PETITIONED PUBLIC HEALTH ASSESSMENT

CABOT-WROUGHT PRODUCTS - DIVISION OF CABOT CORPORATION
(a/k/a NGK METALS/CABOT BERYLCO, INCORPORATED)

MUHLENBERG, BERKS COUNTY, PENNSYLVANIA

CERCLIS NO. PAD044540136

U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations 42 C.F.R. Part 90). In preparing this document ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30 day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

Additional copies of this report are available from:
National Technical Information Service, Springfield, Virginia
(703) 487-4650

FOREWARD

The Agency for Toxic Substances and Disease Registry, ATSDR, is an agency of the U.S. Public Health Service. It was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. (The legal definition of a health assessment is included on the inside front cover.) If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperataive agreements.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists then evaluate whether or not there will be any harmful effects from these exposures. The report focuses on public health, or the health impact on the community as a whole, rather than on individual risks. Again, ATSDR generally makes use of existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further research studies are needed.

Conclusions: The report presents conclusions about the level of health threat, if any, posed by a site and recommends ways to stop or reduce exposure in its public health action plan. ATSDR is primarily an advisory agency, so usually these reports

identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Interactive Process: The health assessment is an interactive process. ATSDR solicits and evaluates information from numerous city, state and federal agencies, the companies responsible for cleaning up the site, and the community. It then shares its conclusions with them. Agencies are asked to respond to an early version of the report to make sure that the data they have provided is accurate and current. When infomed of ATSDR's conclusions and recommendations, sometimes the agencies will begin to act on them before the final release of the report.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-56), Atlanta, GA 30333.

SUMMARY

The NGK Metals Corporation is a beryllium processing plant located approximately four miles north of Reading, Pennsylvania. The beryllium processing plant has released hazardous substances into the environment through on-site disposal of process wastes, wastewater discharge, and air emissions. The Agency for Toxic Substances and Disease Registry (ATSDR) has evaluated data for on- and off-site contamination and its possible impact on human health.

Based upon environmental and exposure data evaluated by ATSDR, concentrations of contaminants detected in air, water[1], soil[2], and sediment are not believed to represent any public health hazard. However, ATSDR has classified the NGK site as an Indeterminate Public Health Hazard. This classification is primarily due to the fact that no data exist for air (prior to 1979) and groundwater (prior to 1990). Therefore, ATSDR is not able to determine whether exposures, through air and groundwater, that may have occurred prior to those dates represent a public health hazard. In addition, ATSDR does not consider other media and exposure pathways likely to present a public health threat; however, additional data and information are needed before such a conclusion can be reached. Additional data needed include on-site soil, off-site surface soil, off-site groundwater, off-site biota, and stream sediment, which is further basis for an indeterminate classification.

Although adverse health effects are not expected based upon concentrations of contaminants detected, ATSDR established completed exposure pathways for on- and off-site ambient air, off-site groundwater (private wells 1 and 2), and off-site surface soil. Potential exposure pathways exist for on-site surface soil, off-site groundwater (private well 3), off-site sediment, off-site surface water, off-site biota, and beryllium worker's clothing.

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[1] In the Initial Release and Public Comment drafts, ATSDR previously indicated that NGK presented a past public health hazard based on human exposure to off-site groundwater in one private well contaminated with chromium and 1,1-dichloroethene. However, based upon current review of toxicological data those past exposures are not expected to result in any adverse health effects and therefore do not represent a past public health hazard. Refer to the chromium and Volatile Organic Compounds subsections in the Public Health Implications section for the detailed toxicological evaluation.

[2] In the Initial Release and Public Comment Release drafts, ATSDR indicated that beryllium found in surface soil at one private residence represented a slight increased risk of cancer. However, after current review of studies regarding carcinogenic effects of beryllium, no increased risk of cancer is expected through ingestion of beryllium. Refer to the beryllium "Ingestion Exposure" subsection of the Public Health Implications section for specific details of that toxicological evaluation.

Current scientific evidence indicates that some humans may have an immunological hypersensitivity to beryllium which could cause chronic beryllium disease to occur in those individuals at relatively low levels. Therefore, ATSDR advises that individuals who suspect they have been exposed to clinically significant levels of beryllium in the past through the inhalation pathway and are experiencing symptoms of shortness of breath, fatigue, weight loss, chest and joint pains, cough, and skin rashes should consider consulting an occupational/environmental medicine specialist to determine whether testing for beryllium sensitivity is appropriate.

Citizens expressed concerns about environmental contamination; pathways of exposure; the potential for adverse health effects, such as brain tumors and cancer; and data quality and regulatory issues. ATSDR has addressed those concerns individually in the Public Health Implications section of this petitioned public health assessment. In an effort to gather additional community concerns ATSDR held availability sessions on June 8, 1993. As a result of the availability sessions, a number of community members discussed health concerns with ATSDR staff, and those concerns have been incorporated into the Community Health Concerns section of this petitioned public health assessment.

The petitioned public health assessment was released for public comment September 1, 1993, through November 12, 1993. Comments received have been listed and addressed in Appendix D of this document. Some comments necessitated revisions to this assessment. Likewise, revisions were made during finalization of this petitioned public health assessment due to additional data and information, and further toxicological research.

ATSDR has made recommendations to eliminate or reduce the potential for future exposures. Recommendations have also been made for additional on- and off-site characterization of environmental media where potentially completed exposure pathways exist, and further information is needed to determine the relevance of these pathways.

ATSDR's Health Activities Recommendation Panel recommended health follow-up actions to conduct a case series or case studies to investigate reported cases of sarcoidosis, health professional and community health education, further toxicological research on beryllium, and referral of this petitioned public health assessment to the National Institute for Occupational Safety and Health for further investigation of work related health concerns. In addition, ATSDR has developed a Public Health Action Plan which outlines the actions to be taken, by ATSDR and involved agencies, at the site subsequent to the petitioned public health assessment.

BACKGROUND

Through its petitioned public health assessment process, the Agency for Toxic Substances and Disease Registry (ATSDR) has evaluated the public health significance of the NGK Metals Corporation site. More specifically, ATSDR has determined whether health effects are possible and has recommended actions to eliminate or reduce the potential for future exposures at this site. ATSDR, which is in Atlanta, Georgia, is a federal agency within the U.S. Department of Health and Human Services and is authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) to conduct public health assessments of hazardous waste sites. ATSDR was petitioned by a private citizen on December 7, 1990, to evaluate the NGK site.

A. Site Description and History

The NGK (Reading) facility, a 65-acre complex, is located along Tuckerton Road between Highways 61 and 222 in Muhlenberg Township, Berks County, Pennsylvania, approximately four miles north of downtown Reading. The site is bounded by Tuckerton Road, Water Street, the Penn Central Railroad (Conrail) and PA Route 61 (Figure 1, all figures are in Appendix A).

Industrial activities began prior to November 1935, when the site was owned and operated by the Pennsylvania Malleable Iron Company. In November 1935, the site was bought by the Beryllium Corporation. Their operations began in March 1936. As a result of consolidations and mergers, the Beryllium Corporation became part of Kawecki Chemical Berylco Industries Inc., and Cabot Corporation. On September 30, 1986, Cabot sold assets of the Reading beryllium alloy plant to NGK Metals Corporation, a subsidiary of NGK Insulators Ltd. of Nagoya, Japan. The plant operates today as the NGK Metals Corporation (1).

No information is available about manufacturing activities at the site prior to 1935. From 1936 to 1965, manufacturing activities at the site included extraction of beryllium hydroxide from beryl ore, and production of beryllium salts and various types of beryllium metal and alloys.

The extraction of beryllium hydroxide from beryl ore was discontinued in 1965. From 1965 to 1992, operations included: production of beryllium copper, beryllium nickel, and beryllium aluminum alloys; casting, heat treatment, and rolling of beryllium alloys; and chemical and mechanical cleaning of beryllium alloys. However, in November 1992, the plant shut down the melting furnaces and hot rolling operations.

Little information is available about waste management activities at the site prior to the early 1950s. During the 1940s, there was a retention basin near the eastern boundary of the plant property adjacent to Tuckerton Road. It is not known what materials were discharged into the basin (1).

During the 1950s and 1960s, the plant used several ponds to treat waste. A series of unlined ponds were used for sludge settling and wastewater treatment. Fluoride waste, spent acids, and acidic rinse waters were neutralized by a lime treatment process and allowed to settle. As the facility grew, wastewater treatment needs changed and the use of settling ponds at the site was discontinued. Before closure, waste treatment ponds were covered with gravel and soil, or with mushroom soil, a highly organic soil composed mainly of manure and top soil. The organic nature of the soil used to cover the settling ponds encouraged grass to grow, and the grass cover served to minimize dust and erosion. Currently, a wastewater treatment facility is in operation.

A separate pond were used for disposal of lime sludge. This area is marked as Pond 6 in the Solid Waste Management Unit map (Figure 2). This pond was excavated and cleaned in the late 1970s and became the site of the existing landfill which is currently permitted for non-hazardous residual waste. The excavated material consisted of soil mixed with wastewater treatment sludge resulting from lime treatment of fluoride wastes, spent acids, and acid rinses. This material was placed in a pile adjacent to the western edge of former Pond 6 and designated Pond 6 waste pile (Figure 2). The Pond 6 waste pile has since been relocated to the southeast quadrant of the facility and covered. The site mapping does not reflect the new location of Pond 6 waste pile.

The Disposal Area Drain Field located in the southeastern corner of the site is believed to have been used in the past as a catchment basin for overflow from the various Solid Waste Management Units. That drain field is the only contaminated waste area that is not currently covered with mushroom soil, pavement, or gravel (2,3).

Other waste disposal areas (Figure 2) include the Southeast Red Mud and Filter Cake Disposal area and the Southwest Red Mud and Lime Disposal area, which stored solid waste in unlined surface impoundments. "Red mud" was the material remaining after extraction of beryllium from the ore (typical chemical composition for red mud: silicon 24-27.5%, fluoride 6.5-10.5%, iron 6.5-9.5%, sodium 1-3%, beryllium 0.3-7.5%, aluminum 6.5-7.5%, potassium 0.5-1%, magnesium, calcium, copper, phosphorous 0-0.5%). By the early to mid-1960s, both of those areas were covered with soil (1).

B. Site Visit

A petition was submitted to ATSDR by a citizen of Reading, Pennsylvania, on December 7, 1990, to investigate allegations of environmental pollution at NGK Metals Corporation in

Reading, Pennsylvania. ATSDR agreed to evaluate the petition and visited the site. Mr. Charles Walters [Agency for Toxic Substances and Disease Registry (ATSDR) Region III Representative], Mr. Joseph Carpenter, and Mr. Timothy Hampton (from ATSDR Headquarters), and a representative of the Pennsylvania Department of Health (PADOH) met with the petitioner on January 29, 1991, to gather information and discuss the petitioner's concerns about the NGK site.

On January 30, 1991, NGK conducted a site visit/meeting and tour of the NGK facilities for ATSDR and other involved agencies. This meeting also included representatives from the Pennsylvania Department of Environmental Resources, Pennsylvania Department of Health, United States Environmental Protection Agency (EPA), the project manager for Dunn Geosciences (NGK's remediation and site evaluation contractor), and other NGK plant representatives. During the site visit, the locations of previous waste management ponds were identified. Also identified were the landfill (operated under a Pennsylvania Department of Environmental Resources residual waste regulation permit), the drum storage area, the raw materials storage area, the discharge pipe from the current wastewater treatment system (operated under a National Pollutant Discharge Elimination System permit), and the acid neutralization tank. In addition, areas contaminated during past operations were observed. Access to the site is limited by an eight foot chain-link fence surrounding the site and a 24-hour security guard service.

ATSDR solicited health concerns from interested parties. Besides interviewing the petitioner, interviews were conducted with other concerned citizens, Commonwealth agencies, and a representative from the Muhlenberg Township Water Authority. Those interviews provided valuable information about state environmental monitoring data, community health concerns, reports of unusual illnesses, and water quality of the Muhlenberg Township water supply.

C. Demographics, Land Use, and Natural Resource Use

Demographics

NGK and Muhlenberg Township are located in Berks County, Pennsylvania. ATSDR obtained 1990 demographic information for a one and two-mile radius around NGK and for Berks County to help characterize the area population (see Table 1 and Figure 3).

Population estimates within a 1- and 2- mile radius of the facility are 4,927 and 14,686 respectively. The population characteristics within a 1- and 2- mile radius are very similar. The site area population is predominantly white (98%) and, compared to Berks County, there is a noticeably larger percentage of persons in the older age categories (i.e., 45 to 64 and 65 and over). There is also a smaller percentage of females near the site in the age group 15-44, which is considered the primary child-bearing age. The fact that the majority of the

housing units are owner occupied suggests a relatively stable area population. The median housing value around the site area is lower than for Berks County and the difference is more pronounced within 1-mile of the site (4).

Land Use

The NGK Metals site is surrounded by commercial and residential land uses. Several light industries are located across the street from the site on NGK's southern boundary. An active railroad line (Conrail) is adjacent to its eastern border. Residences are located within 50-100 yards south of NGK. A cemetery, church, and small businesses also surround the property.

Natural Resource

Muhlenberg Township Water Authority and Reading Bureau of Water supply the public water for domestic and industrial use within a 3-mile radius of the site. Muhlenberg Township began public water service in the late 1940s to 1950s. Within a 3-mile radius of the site, the Muhlenberg Township Water Authority has a total of 11 production wells; one of the eleven wells, the Reading Crest Well (approximately 500 feet deep), is not in service. The City of Reading draws water from Lake Ontelaunee located approximately 2.5 miles north of the site.

Water from private wells in the area has been used for drinking purposes. EPA required NGK to conduct a water well inventory in Muhlenberg Township during the spring of 1991. The well inventory concentrated on areas immediately surrounding the site and hydraulically downgradient of the site (approximately 2-3 miles southwest). Two private wells (with depths of 125 and 150 feet) were identified in the EPA specified well inventory area. In addition, private wells outside of the EPA designated well inventory area were observed (5). Further information regarding the well inventory and the water quality analyses of these wells will be discussed in the Off-site Contamination and the Off-site Groundwater Pathway subsections.

A local stream next to the southern boundary of the site (Laurel Run) flows approximately 2 miles southwest until it converges with the Schuylkill River. Laurel Run is a small stream, but flows the entire year.

The Schuylkill River discharges to the south, joining the Delaware River at Philadelphia, and acts as the primary drainage pathway for the region. The river supports a wide range of activities, such as sport fishing from boats and river banks. Local fishermen report that many people fish and swim just below the Laurel Run and Schuylkill River confluence. The Schuylkill is also used as a water source by downstream towns.

The groundwater system in the vicinity of the NGK site consists of a discontinuous unconfined aquifer made of unconsolidated clay, sand, and gravel overlying fractured bedrock. Two aquifer zones have been defined: the first 100 feet (shallow zone) and between 100 to 200 feet below ground surface (deep zone). There are no on-site wells extending greater than 200 feet below the ground surface (1). There is no confining layer between the different aquifer materials. Groundwater flow beneath the NGK site is generally to the west within the shallow aquifer zone, with groundwater flow to the northeast in the northern portion of the site (1,2,3). Groundwater in the deep aquifer zone follows regional groundwater flow which trends west-southwest toward the Schuylkill River (3,6). A downward vertical groundwater flow exists beneath the site with the exception of the area closest to Laurel Run. Here the vertical gradient is reversed and groundwater flows from the deep zone to the shallow zone. Laurel Run is believed to be hydraulically connected to groundwater zones below the site. Laurel Run appears to be recharging the aquifer near the site, but further downstream (approximately 1 mile) the groundwater zone appears to be discharging to Laurel run (1,6).

D. Health Outcome Data

The Pennsylvania Department of Health (PADOH), Eastern District, was contacted by ATSDR for health outcome data. The State of Pennsylvania has a cancer registry, containing data collected during the last nine years; however, lag time in establishing the registry statewide and a high background cancer incidence in the state limit the usefulness of this registry to ATSDR at this time. Cancer is a disease that can develop years after the exposure to the causative agent. Although the database may reflect the consequences of chronic exposures beginning 20-30 years earlier, the relatively few years of information recorded by the database cannot reveal any trends in cancer incidence in the area over the 60 year life of the NGK facility.

COMMUNITY HEALTH CONCERNS

Concerns about NGK from nearby residents in Reading or Muhlenberg Township were received by the PADOH, Eastern District. A majority of the concerns centered around requests for a health study. Several citizens who met with ATSDR also suggested that a health study should be conducted. ATSDR staff has met with the petitioner on several occasions to discuss concerns regarding NGK. Community members expressed concerns, as well as asked questions of ATSDR staff, during the site visit and the availability sessions that were open to the public. In addition, some community health concerns were gathered during telephone conversations with local residents and through letters written to ATSDR. Based on those letters, interviews, and information gathered during the site visit and availability sessions, the following community health concerns were identified:

1. The chemicals (chromium and fluoride) found in a local private drinking water well might cause cancer.

2. Contaminated on-site groundwater could contaminate local drinking water supplies.

3. Airborne dust from NGK's old wastewater treatment lagoons might cause health problems.

4. Residents living in the Reading area may develop sarcoidosis from exposure to beryllium oxide.

5. Untreated storm water runoff and treated wastewater from NGK that are discharged into Laurel Run could be having a detrimental effect on aquatic wildlife. Furthermore, the treated waste and untreated storm water that are discharged into Laurel Run may eventually reach Schuylkill River (via Laurel Run) and contaminate local water supplies down river.

6. Some people may have contaminated private wells and may be unaware of contaminated groundwater. This may affect people who have summer homes and were not interviewed during the well survey.

7. The Reading Crest Well water is contaminated, and attempts have been made in the past to bring the well into service. There is concern that the well may be brought on-line in the future.

8. Laurel Run is impacted by contaminants in surface water from wastewater discharged from NGK. There is concern for the health of children who play in Laurel Run and persons who may have eaten or may currently be eating fish from Laurel Run or at the confluence of the Schuylkill River and Laurel Run.

9. The present parameters for the NGK National Pollutant Discharge Elimination System (NPDES) permit are too high, and compliance for the new, more stringent, standards is not required until August 1993. The Pennsylvania Department of Environmental Resources (PADER) and EPA have delayed compliance deadlines several times already.

10. Deposition from air emissions from the metal facility over its entire history has accumulated in homes and on lawns throughout the community. Such contamination is believed to have impacted the health of persons in the community in the past and could be a current and future health threat.

11. The analytical procedure used to analyze the concentration of beryllium from air monitoring conducted since 1979 not measuring all forms of beryllium present in the sample and therefore, is not revealing the actual concentration of beryllium present in the air.

12. There are no air monitors due south of the NGK plant to detect the levels of beryllium in which the nearest residents (along Water Street) might be exposed.

13. People have developed brain tumors and lung cancers due to exposure from site-related contaminants.

14. The community could be exposed to contaminants during remediation when the solid waste management units are consolidated.

15. What is beryllium poisoning and its symptoms? Once absorbed, where does it go?

16. Health conditions that were reported by citizens as having occurred or occurring in the community include: children with liver problems, heart problems, asthma, and allergies; cancers of various types; emphysema and general respiratory illnesses; berylliosis; Parkinson's disease; Hodgkin's disease; brain tumors; myopathy; mottling of teeth; brittle bones; hair loss; rashes; irritation at night; lots of colds; and a degenerative condition resulting from the side effects of treatment for beryllium poisoning.

17. Could a child with asthma be more susceptible to beryllium?

18. Dust carried home, from the beryllium plant, on worker's clothing may have resulted in illnesses.

19. Exposures may result from residential gardens, community parks, and playing fields.

20. Could contaminants in groundwater cause respiratory infections from showering or cause mottled teeth, stress fractures, and colic in children?

21. Work practices at the plant were very poor and dusty in the past.

22. Exposures may have occurred from going on site before the site was fenced or from fields or caverns where contamination was dumped.

23. There are a lot of illnesses around the site, particularly in the Cherokee Ranch area.

24. Possible health hazards such as digging at or around the site, contaminated off-site groundwater, and air violations have not been communicated to the public.

25. Lake Ontalaunee, from which the City of Reading gets its water supply, is being contaminated with beryllium.

26. Further contamination may have resulted from floods on Laurel Run in the past and dredging conducted by the Army Corp of Engineers.

27. Orange and green colored smoke that caused a burning sensation was emitted from plant stacks in the past. Ash from the plant would deposit on automobiles and seemed to deteriorate paint.

28. Water in Laurel Run turns strange colors when it rains. Could water from Laurel Run that was used on gardens in the past be a health concern?

29. There is a concern that the RCRA Facility Investigation conducted by Dunn Geoscience Corporation and air monitoring data collected by NGK are not reliable sources of information.

30. Do elevated levels of CD4+ T cells in the lung or blood make people more susceptible to chronic beryllium disease? What is a normal CD4+ T cell count and what would be abnormally high? Should OSHA or ATSDR check the CD4+ T cell count of people who work at and live around beryllium alloy manufacturing facilities? Is beryllium the antigen in chronic beryllium disease? Is it possible that sarcoidosis has been analyzed in cases that may actually be chronic beryllium disease? If beryllium shows up in a biopsy of lung tissue (dried) from a person diagnosed with sarcoidosis, at what concentration (ppm) would it be a questionable case of chronic beryllium disease?

31. Is anyone doing research on a connection between beryllium and brain tumors or arthritic conditions resulting from absorption and or ingestion of beryllium?

Some of those questions and concerns are addressed in various discussions and evaluations throughout the document; however, at the end of the Public Health Implications section, specific responses are given to each individual concern listed here.

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

Contaminants of concern are contaminants found on or off site that are at concentrations that might pose a threat to public health. The mere presence of a contaminant being discovered on-or off-site does not imply that a health threat exists. This petitioned public health assessment will evaluate all the contaminants of concern in an effort to determine if there is any threat to public health. ATSDR selects and discusses these contaminants based upon the following factors:

1. Concentrations of contaminants on and off the site.

2. Field data quality, laboratory data quality, and sample design.

3. Comparison of on-site and off-site concentrations with background concentrations, if available.

4. Comparison of on-site and off-site concentrations with public health assessment comparison values for (1) noncarcinogenic endpoints and (2) carcinogenic endpoints.

5. Community health concerns.

In this section, comparison values used in ATSDR public health assessments will be compared to contaminant concentrations in specific media (e.g., air, soil, groundwater) used to select contaminants for further evaluation. ATSDR and other agencies developed those values to provide guidelines for estimating the media concentrations of a contaminant that are unlikely to cause adverse health effects, given a standard daily ingestion rate and standard body weight. However, the fact that the concentration of a chemical exceeds a given comparison value does not necessarily imply that it is likely to produce adverse health effects. The conditions of exposure and the individual susceptibility factors will determine whether or not the intrinsic toxic potential of a chemical is likely to be expressed. See Appendix C for a description of the comparison values used in this petitioned public health assessment.

ATSDR examines the Toxic Chemical Release Inventory (TRI) to determine if there is any known information on sources of potential contamination in the vicinity of the site or sites in question. The TRI contains information on estimated annual releases of toxic chemicals to the environment (via air, water, soil or underground injection), which are voluntarily reported by companies to EPA. TRI data can be used to give a general idea of the current environmental emissions occurring at or near a site. TRI data may also be used to determine whether the ongoing emissions from reporting facilities might be contributing additional environmental contamination.

A search of the TRI revealed that other Berks County industries were found to release similar contaminants to those found at the NGK site. Those industries were identified by examination of the Toxic Chemical Release Inventory (TRI) for 1989. A metal processor in the northern portion of the County (near Shoemakersville) releases small amounts of beryllium into the air and into a tributary of the Schuylkill River. Because of the distance from NGK, this release is unlikely to impact the Reading area. Two sources of cadmium releases were found in the City of Reading. Large amounts of chromium (282,202 lbs/yr) were released by 10 industrial facilities within the County, four within the Reading area. Trichloroethene was released by three Reading area industries (a total of 303,300 lbs/yr released into the air and 97 lbs/yr into surface water).

A. On-site Contamination

Surface Soil

No surface soil sampling data were available for ATSDR's review. During the late 1960s, many of the waste areas were covered with a highly organic material referred to as "mushroom soil." The mushroom soil was used to cultivate vegetation as ground cover in an effort to prevent erosion and migration of waste (1). The Disposal Area Drain Field is the only waste area that has not been covered (i.e. by mushroom soil, pavement, or gravel) (2,3).

Subsurface Soil

Subsurface soil samples were collected from the Southwest Red/Lime Sludge Area, the Southeast Red Mud Filter Cake Disposal Area, Pond 1, Pond 2, Pond 3, Pond 6, Former Pond 6 waste pile, Former Government Ore Stockpile, Retention Basin, Disposal Area Drain Field, and Sludge Settling Tank Area (Figure 2). Subsurface soil borings and samples were done at some waste areas down to a depth of approximately 15 feet. Arsenic, beryllium, cadmium, total chromium, and copper were detected at concentrations that exceeded comparison values in on-site subsurface soil. Although there is no comparison value for lead in soil, it was also detected in on-site subsurface soil and will be retained as a contaminant of concern, requiring further consideration (1). Table 2 (all tables are in Appendix B) shows the maximum concentrations of specific chemicals of concern in subsurface soil on site.

Groundwater

Thirty-one on-site monitoring wells, located in shallow (0-100 feet) and deep (100-200 feet) aquifers under the NGK facility, have been sampled. Three rounds of samples have been collected (December 1989, May 1990, and June 1991) from many of the wells. The six newest wells have only been sampled once. Samples (both unfiltered and field filtered) were analyzed for metals, priority compounds, and volatile organic compounds (VOCs). Groundwater samples from on-site monitoring wells (Figure 4) revealed contaminant concentrations that exceeded comparison values for a number of contaminants. Both shallow and deep aquifers showed contamination (1,6). A summary of the maximum concentrations of those contaminants detected in on-site groundwater displayed in Table 3.

Four shallow wells existed prior to the RCRA Facility Investigation and sampling was conducted on a quarterly basis by NGK, dating back to about 1981. Some of the highest contaminant concentrations found in on-site groundwater were detected during the early 1980s (7). However, ATSDR will use only the most current on-site groundwater data to evaluate contamination since on-site groundwater has not been used.

Ambient Air

NGK conducted an on-site air monitoring program from June 25, 1991 to July 30, 1991. Sampling and analysis protocols were approved by EPA for NGK under its beryllium National Emissions Standards for Hazardous Pollutants (NESHAP) sampling program. Sampling was accomplished using 24-hour high volume samplers which were run for 7 days and analyzed based on air flow during the 7-day periods. Filters were analyzed for beryllium and chromium (2,8).

The on-site ambient air sampling locations (RCRA 01 and RCRA 02) were located east of the Disposal Area Drain Field and Former Pond 6 waste pile, respectively, to monitor the potential impacts of those waste areas. The locations of those monitors can be seen in Figures 5 and 6 (8). Table 10 lists the concentrations of total beryllium and total chromium that were recorded during the program.

During the June 25-July 30, 1991, sampling event, the plant operations were reportedly shut down during the final two weeks of July. That sampling plan was to provide ambient air data during production and non-production periods (8). Ambient air results during the last two weeks (non-production period) of July 1991 (July 16-30, 1991) do not vary greatly from the first three weeks (production period). Furthermore, in comparing the on-site monitors (RCRA 01 and RCRA 02) to the nearest off-site monitor (R-1) for this 5 week sampling event, chromium was always detected at a higher concentration off site and beryllium was always detected at a higher concentration on-site. Based on weather observations from the Reading Airport, located approximately two miles southwest of NGK, wind was predominately out of the west/west-northwest during the 5-week sampling period (9). For each week reviewed, higher beryllium air concentrations appear to correspond to winds coming from the west and north (NGK and the waste field). Chromium concentrations, however, do not correspond as clearly to winds from the west and north. Although NGK may be a potential source of chromium, via fugitive dust emissions, data tends to indicate that other sources, such as those identified by the TRI search, may be impacting air quality at the NGK site.

None of the results of the on-site ambient air sampling exceeded the Occupational Safety and Health Administration's (OSHA) Permissible Exposure Limits (PELs) time-weighted average standards. The OSHA limits are based on time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which all workers may be occupationally exposed, day after day. However, three beryllium samples and all of the chromium samples exceeded the ATSDR comparison values and will therefore be discussed as contaminants of concern in the Pathways Analyses and Public Health Implications sections.

Issues regarding the quality of ambient air data are discussed in the Quality Assurance/Quality Control subsection.

B. Off-site Contamination

Soil

On November 18, 1992, one surface soil sample was collected off-site. That sample was collected from the lawn of a private residence approximately 1 mile southwest of NGK. The soil sampling was initiated by the owners of the home and was analyzed for beryllium, chromium (total and hexavalent), and fluoride, which were contaminants detected in their well (see Table 4a, private well 1). Beryllium was detected at a concentration of 2.12 milligrams per kilograms (mg/kg), which exceeds the Cancer Risk Evaluation Guide (CREG) comparison value of 0.2 mg/kg (a description of comparison values used by ATSDR can be found in Appendix C) (10). None of the other contaminants exceeded comparison values. The surface soil sample results and location are listed under Residence #7 in Table 5 and Figure 7, respectively.

Additional surface soil samples were collected in public and private areas around NGK on July 27, October 25, and October 26, 1994 (11, 12). The July 1994 samples were collected at four public locations around the site. The sampling locations are in Figure 7, listed as PA-1, PA-2, PA-3, and UG-1. Based upon prevailing wind directon, the samples collected at UG-1 and PA-3 are located most directly upwind and downwind, respectively, of NGK. Although the upwind samples were intended to indicate background, the proximity to the site and evidence of beryllium detected in air at that location, do not provide for adequate background data (13).

Three composite soil samples were collected at each of the above mentioned locations and analyzed for beryllium (total and soluble), chromium (total), and fluoride. Eleven samples, ranging from 0.77-6.9 mg/kg, revealed total beryllium concentrations that exceeded the CREG comparison value of 0.2 mg/kg (11). Only one of the soluble beryllium samples revealed a concentration above the detection limit. That sample, which was collected at UG-1, was back calculated to a soil concentration of 0.0054 mg/kg, which does not exceed the CREG comparison value (14). Since chromium samples were not analyzed for both total and hexavalent or trivalent chromium, the samples were screened using the *pica child* RMEG comparison value of 10 mg/kg, for hexavalent chromium. *Pica child* refers to a behavior of children who have an excessive habit of ingesting nonfood items. They may intentionally ingest 25 times more soil than a child who does not exhibit pica behavior. Concentrations of total chromium were detected in 11 samples, ranging from 17-31.5 mg/kg, which exceeds the comparison value (pica child RMEG) for hexavalent chromium, but not for trivalent chromium. One sample, for both beryllium and chromium, was below the laboratory's detection limit. None of the fluoride samples exceeded comparison values (11). The surface soil sampling results for the public locations are in Table 5.

During the October 1994 sampling, 38 surface soil samples were collected in residential areas around NGK and analyzed for total beryllium and chromium. Concentrations of beryllium exceeded the CREG comparison value in 37 samples, which ranged from 0.5-4.9 mg/kg. Beryllium was below the laboratory detection limit in one sample. Concentrations of total chromium exceeded the pica child RMEG comparison value for hexavalent chromium in 37 samples, which ranged from 10.2-92.6 mg/kg (12). However, total chromium did not exceed the pica child RMEG (2,000 mg/kg) for trivalent chromium in any of the samples. The surface soil sampling results and locations are listed as "residences," numbering 1-6, in Table 5 and Figure 7, respectively.

Groundwater

Off-site groundwater sampling has been conducted at three private wells, three monitoring wells, one piezometer, the Reading Crest Well and a well at the Berks Products Quarry (see Figure 8) (6). All of the wells, except private well 3, are within the EPA specified well inventory area. Private well 1 was sampled on December 6, 1990; December 26, 1990; and June 1991. Private well 2 was sampled on May 30, 1991; June 1991; and July 27, 1994. The Reading Crest Well was developed as a municipal supply well but has never been used; it has been sampled numerous times in the past (1,5,6,15,16,17). The other off-site wells have only been sampled once (June 1991). Private well 3, monitoring well 24, and the piezometer represent the shallow aquifer (< 100 feet) and all other off-site wells represent the deep aquifer (100-200) (6).

Arsenic, beryllium, cadmium, chromium (total and hexavalent), selenium, fluoride, 1,1-dichloroethene, tetrachloroethene, and trichloroethene were detected in off-site groundwater at levels exceeding comparison values. Some of the contaminants detected in on-site groundwater were not analyzed in off-site groundwater samples. Also, the detection limits for some contaminants analyzed in off-site groundwater are greater than our comparison values. It is not possible to determine whether or not the analyte concentration exceeds comparison values when the detection limit is greater than comparison values. The maximum concentrations, contaminants analyzed, and the detection limits that were reported for contaminants that were not detected for each location sampled are given in Tables 4a, 4b and 4c.

Surface Water

Through stream surveys and the RCRA Facility Investigation, surface water in Laurel Run has been sampled upstream and downstream of NGK on seven occasions. Water quality data for Laurel run are available for the years 1981, 1989, 1990, and 1991. Data from those sampling events are reported in Tables 6a, 6b, and 6c.

Concentrations of beryllium (2500 micrograms per liter [μg/L]), lead (36 μg/L), manganese (450000 μg/L), fluoride (870 μg/L), dichloromethane (methylene chloride) (45 μg/L), and tetrachloroethene (1 μg/L) exceed comparison values (6,18,19). Some of the detection limits for arsenic and beryllium are too high. As discussed above, lower detection limits should be used. The highest concentrations of beryllium and manganese, which were reported in the May 13, 1981 stream survey, are unusually high in comparison to the other surface water data (see the Quality Assurance/Quality Control subsection for more information regarding this data). All other data consistently show lower concentrations.

A number of facilities and activities in the past and present contribute to pollution in Laurel Run. Some of the possible sources of pollution include: mushroom farming, a limestone quarry, a lead storage battery plant, a truck terminal, a beryllium processing plant (NGK and its predecessors), and wet-weather highway runoff.

Based on the surface water data, it is difficult to determine what source or sources are contributing greatest to water quality problems in Laurel Run. The highest concentrations of lead, manganese, fluoride, and dichloromethane detected in Laurel Run are found at locations well downstream from NGK rather than at the downstream location closest to the NGK NPDES outfall. If NGK is the primary source of those contaminants, concentrations would likely be greatest just below the NGK NPDES outfall, with decreasing concentrations further downstream as water volume increases. However, groundwater is recharging Laurel Run further downstream, in which case contaminated groundwater from NGK could be a possible source.

In comparing the samples taken upstream and downstream of the NGK wastewater discharge for each sampling event (i.e., comparing samples taken on the same date), increases in beryllium and copper concentrations are always shown. In the same type of comparison, an increase in lead and manganese concentrations is shown in only part of the samples. No other relationship between upstream and downstream contaminant concentrations is seen, although the limitations of the data (i.e., detection limits greater than concentrations being discharged) may have prevented such relationships from being observed. Table 7 shows the contaminants found in NGK wastewater discharge. No appropriate comparison values are available; therefore, no comparison values are reflected in that table. However, from this information we can determine that detectable levels of beryllium, cadmium, chromium (total and hexavalent), copper, lead, nickel, nitrate, and fluoride are discharged to Laurel Run (20,21,22,23).

Sediments

During the RCRA Facility Investigation sediment samples from Laurel Run were collected in December 1989, May 1990, and June 1991. Sediment was collected from the same locations

during each sampling event. One sample was taken upstream from the NGK NPDES outfall and two samples were taken downstream of the NGK NPDES outfall (1,6).

Arsenic and beryllium concentrations exceeded comparison values for sediment at all the sampling locations. No other contaminants analyzed exceeded comparison values. Arsenic concentrations were generally greater downstream of the NGK NPDES outfall than those upstream. All of the samples downstream of the NGK NPDES outfall showed higher beryllium concentrations than the concentrations detected upstream of the NPDES outfall. The difference between the upstream and downstream concentrations for both beryllium and arsenic were marginal, varying only 1-2 μg/L. Data from all three sampling events are in Table 8.

On September 17, 1991, a PADER Water Quality Specialist reported observing unusual sediment on rocks in the NGK NPDES discharge zone of Laurel Run. The unusual sediment materials were washed from some of the rocks, and the materials that settled out were poured into 500 milliliter sample bottles and fixed with acid. On October 1, 1991, after a couple of weeks of heavy rains, the same sampling process was repeated taking one sample upstream and one sample downstream of the NGK NPDES discharge. In addition, a sample of NGK's wastewater effluent was taken during both sampling events and are included in Table 7 (22).

The sediment was not analyzed on a dry weight basis (mg/kg), but was acid-digested and analyzed as a solution (μg/L). This type of analysis would indicate what contaminants can be aggressively (by acid-digestion) leached out of the sediment, but the concentration cannot be compared to comparison values for exposure purposes.

The upstream sediment sample collected on October 1, 1991, revealed beryllium (5.8 μg/L), copper (766 μg/L), lead (248 μg/L), and nickel (39 μg/L). Total chromium was analyzed but was not detected at a detection limit of 50 μg/L. The samples collected downstream of the NGK NPDES outfall revealed beryllium (7290 & 2440 μg/L), total chromium (276 & 160 μg/L), copper (1845000 & 615000 μg/L), lead (104000 & 11700 μg/L), and nickel (19600 & 7290 μg/L) for the September and October 1991 samples, respectively (22). Given the generally low level of contaminants in the stream sediments, these results need further confirmation. In particular, to evaluate their health significance, ATSDR needs to know the amount of these highly contaminated materials (in mg/kg), their distribution within the stream, and possibly their source. See the Quality Assurance/Quality Control subsection for more information regarding this data set.

Ambient Air

Air monitoring data for NGK were reviewed for the years 1979 to 1993. Monthly average concentrations of beryllium were reported in $\mu g/m^3$, at 8 stations surrounding the NGK

facility (location of air monitoring stations, otherwise discussed as R-1 through R-8, can be found in Figure 9 numbered simply 1 through 8). Only air sampling for beryllium has been required under the NESHAP regulatory program. Table 9 shows the maximum weekly beryllium concentrations reported for each year since 1979. The same sampling and analysis protocols described in the On-site Contamination subsection were used for off-site ambient air monitoring.

Cabot Berylco reported abnormal stack emissions due to problems with their collector system between December 30, 1980, and February 6, 1981, to which they attributed a high value of 0.04279 $\mu g/m^3$ at monitor R-1. High concentrations for the year of 1981 were also reported for monitors R-5 through R-8 during that time period (see Table 9).

NGK reported two violations of the NESHAPs regulatory limit of 0.01 $\mu g/m^3$. The NESHAPs standard is based on a monthly (30-day) average. Violations occurred in June and August 1989 during the excavation of red mud for the construction of a new building (3,24). Following those two events, the air monitoring station (Figure 9, station R-1) closest to the site recorded high weekly concentrations of 0.08143 $\mu g/m^3$ and 0.02972 $\mu g/m^3$ for beryllium in June and August 1989, respectively (25).

Beryllium concentrations recorded on a weekly basis at the R-1 and R-3 stations have exceeded the environmental comparison value of 0.0004 $\mu g/m^3$ (CREG) for at least 1 week during each year since this sampling program began in 1979.

Off-site ambient air data are available for chromium. Chromium was sampled for at the R-1 station (the off-site station closest to NGK, see Figure 9) during the June 25-July 30, 1991, RCRA ambient air sampling program. Chromium concentrations at the R-1 station exceeded the CREG comparison value during each week of sampling. The results for the off-site station (designated as R-1) can be found in Table 10; in addition, that table includes on-site monitoring data for the stations designated as RCRA 01 and RCRA 02.

Issues regarding the quality of ambient air data are discussed in the Quality Assurance/Quality Control subsection.

Biota

To date, there are no analytical data available for off-site biota (e.g., fish and garden vegetables). Such information is needed to fully evaluate any potential public health impacts. Biota in the areas surrounding NGK and along Laurel Run might be contaminated with chemicals found in Laurel Run's surface water and sediments, off-site groundwater (possibly used for gardening or agricultural purposes), and in off-site ambient air.

C. Quality Assurance/Quality Control

During preparation of this petitioned public health assessment, ATSDR relied on the information provided in the referenced documents and assumed that adequate quality assurance and quality control (QA/QC) measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The validity of the analyses and conclusions in this petitioned public health assessment is determined by the completeness and reliability of the referenced information. However, items or issues of concern regarding data quality that were identified by ATSDR are discussed below.

Groundwater samples taken from monitoring wells represent both unfiltered and field filtered samples. EPA Drinking Water Standards and ATSDR health comparison values are based on unfiltered samples. Field filtered samples are sometimes ten or more times lower in concentrations than unfiltered samples, but should always be lower than unfiltered samples. A few groundwater samples showed filtered samples at higher concentrations than the unfiltered samples. ATSDR has reported the highest concentration in such cases.

Groundwater was analyzed for mercury during on-site sampling in December 1989 and May 1990. Mercury was reported at a concentration of 56,900 μg/L (unfiltered) and 33,900 (filtered) in monitoring well 14A for the December 1989 sampling event. No quality assurance or quality control problems were reported for those samples. However, such results are unlikely since: (1) mercury was not detected in the May 1990 groundwater analysis for monitoring well 14A, (2) mercury was only detected in three other on-site monitoring wells, with a maximum concentration of 0.4 μg/L, during the December 1989 and May 1990 groundwater sampling, (3) mercury was detected at relatively low levels in on-site subsurface soil, with a maximum concentration of 4.1 mg/kg, and (4) mercury is not a component of the NGK waste stream. Laboratory error, sample contamination, or an error in reporting are some of the possible situations which could have occurred. Based on all of the above mentioned factors, ATSDR does not regard those elevated samples as representative and; therefore, they will not be evaluated as such.

Beryllium and manganese reported in surface water samples collected during a stream survey on May 13, 1981, were approximately 1000 times higher for beryllium and 10,000 times higher for manganese than concentrations reported for those contaminants during other sampling events. In the stream survey, the concentrations were reported in milligrams per liter (mg/L) and it is possible that a 1000 fold increase resulted if the laboratory reported those values in micrograms per liter (μg/L), but the numbers were transposed for the report. ATSDR was unable to acquire a copy of the original laboratory analysis to investigate this matter. In giving further consideration to those concentrations, it should be noted that the data were collected in 1981 and the other data were collected 8, 9, and 10 years later when water quality might have improved. In addition, the sample that was described in the Off-site Sediment subsection (although it is not truly representative of surface water) shows that

suspended solids found in the stream are capable of producing beryllium concentrations in the 2500 μg/L range. Therefore, ATSDR will accept the beryllium and manganese concentrations as reported. The stream survey reported that samples at Station 1 (listed as DS1 in Table 6b), which was originally indicated as the upstream location and Station 2 (listed as US1 in Table 6b), which was originally listed as the downstream location, may have been switched. The data appear to indicate that this is a possibility based on the higher beryllium, fluoride, and copper concentrations shown at station 1 (DS1). Therefore, in Table 6b of this petitioned public health assessment, Station 1 is reported as the downstream location nearest to NGK, and Station 2 is reported as the upstream location. No other quality assurance or quality control problems were reported.

The three samples of unusual sediment that were collected on September 17, 1991, and October 1, 1991, were not analyzed as dry weight sediment samples. The samples were fixed with acid and analyzed as a water sample would have been. However, ATSDR will consider those samples as being representative of the sediment, since sediment was the basis of collection and the focus of the analysis was to identify contaminants leached from the sediment. The data provided from those analyses would more likely represent a sediment exposure than a surface water exposure. Furthermore, no comparison values are applicable to this type of sample. Therefore, ATSDR has only reported the concentrations for those contaminants which were identified as contaminants of concern in on-site media.

Several issues regarding the quality of ambient air sampling data have been raised through a community concern and discussions with EPA. One issue is that the sampling method may be causing some data quality problems. The sampling method, as described earlier, is to run the 24-hour high volume samplers for 7 days before having the filter analyzed rather than on a daily basis which is typically done. The sampling method utilized by NGK had received EPA approval to operate on a continuous basis and is considered to raise data quality questions only for those samplers which are recorded as having low flow (below 39 cubic feet per minute) or as having shut down at some point between daily flow checks by NGK staff. Severe restriction of flow or stopped flow results in inconsistent particle size sampling. The particle sizes sampled under low-flow conditions are not necessarily those upon which the NESHAPs standard was based. For the data submitted by either NGK or Cabot Berylco since 1979, the occurrence of interrupted flow has been recorded and does not involve the June and August 1989 excursions, when the NESHAPs regulatory limit was exceeded. The other air data issue of concern is that the analytical procedure used may not be revealing the total concentration of beryllium (particularly beryllium oxide) that is present in the sample. The analytical method currently being used is an approved EPA method and is being conducted by an approved laboratory. EPA is currently investigating both of those issues. Until those issues are resolved and conclusions determine otherwise, ATSDR will evaluate the ambient air data as they are reported since no other data are available to evaluate. If the EPA investigation of those issues indicate that the sampling and or the

analytical method are unrepresentative of the actual beryllium concentration in off-site air, then ATSDR will reassess the data based on those conclusions.

D. Physical and Other Hazards

The physical hazards on site are common to a metal processing plant, and include materials movement, waste handling, and furnace operations. Other than heavy metal parts, metal cutting machines, acid pickling vats, and high temperature furnaces (all of which were to be shut down in November 1992), no unusual physical hazards were noted. The site is secured by a fence (portions not fenced at the edge of the parking lot are in view of 24-hour security personnel).

PATHWAYS ANALYSES

To determine whether residents in the Muhlenberg Township are exposed to contaminants migrating from the site, ATSDR evaluates the environmental and human components that lead to human exposure. This pathway analysis identifies five elements: 1) source of contamination, 2) transport through an environmental medium, 3) a point of exposure, 4) routes of human exposure such as ingestion, inhalation, or dermal absorption, and 5) a receptor population. ATSDR classifies exposure pathways as completed, potential, or eliminated. A completed pathway existed in the past, and may exist in the present or future if all five elements of an exposure pathway link the contaminant source to a receptor population. Potential pathways, however, are defined as situations in which at least one of the five elements is missing, but could exist. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. Pathways are eliminated when at least one of the five elements is missing and will never be present. Completed and potential pathways may also be eliminated when they are unlikely to exist.

A. Completed Exposure Pathways

A list of completed exposure pathways is in Table 11 of Appendix B.

Off-site Groundwater

During the Phase I RCRA Facility Investigation (November 1990) a well inventory, which consisted of reviewing existing state records of private well locations, was conducted. This inventory identified several wells, including private well 3, west of NGK (1). Another well was identified (private well 1) and sampling of that well was requested by EPA in the Phase I RCRA Facility Investigation Addendum (15). In the spring of 1991 a door-to-door water well survey was conducted, at EPA's request, to identify any additional private wells. An area surrounding and hydraulically downgradient (up to 2-3 miles) of NGK was specified by

EPA to be surveyed. During the survey a total of 465 residences and businesses were inventoried. One well (private well 2) was identified as being used for consumption and other domestic purposes (5).

Private wells 1 and 2 revealed contaminants that exceed comparison values. All of the contaminants detected in private wells 1 and 2 were detected at elevated levels in on-site groundwater. The detection limit of some contaminants analyzed for private wells 1 and 2 are above comparison values (see Table 4a).

Private well 1 is no longer in use, but was used from 1983 to May 1991, when the well was disconnected and the house was connected to the Muhlenberg Township water supply (5,6). Private well 2 was installed around 1950 and is currently in use. Initial sampling (May 1991) of private well 2 did not reveal any contaminants above comparison values; however, a second sample in June 1991 showed total chromium at 52.7 μg/L, slightly above the Reference Dose Media Evaluation Guide (RMEG) comparison value of 50 μg/L (5,6). Private well 2 was last sampled on July 27, 1994, and no contaminants, including chromium, exceeded comparison values (11).

A past completed pathway exists through ingestion, dermal contact, and inhalation routes for the family of 4 (2 children and 2 adults) that used water from private well 1. A current completed pathway exists through ingestion and dermal contact for the family that is presently using water from private well 2.

On-site Ambient Air

No data are available that indicate that on-site workers were exposed to beryllium or chromium in the ambient air that exceed OSHA limits. However, ATSDR will also consider on-site workers, who also live near the site, that may have received additional exposures of beryllium and chromium for extended periods of time (i.e., greater than 8 hours a day or 40 hours a week) over the course of their lifetimes. See Tables 9 and 10 for on-site and off-site ambient air data.

Past, present, and future completed pathways for beryllium and chromium, via inhalation, exist for on-site workers. An accurate estimate of the receptor population cannot be determined, but as many as 1,000 people have worked at NGK in the past and as few as 100 people are currently working at NGK.

Off-site Ambient Air

Off-site ambient air represents past, present, and future completed pathways for people living and working near the NGK plant. Based on ambient air data in Table 9, concentrations of beryllium have exceeded the CREG comparison value at all of the 8 monitoring stations in

the past and in 1994 exceeded the comparison value at each of the eight stations. NGK instituted changes in plant operations in November 1992, which includes shutdown of the melting furnaces and hot rolling operations. Despite these changes, air sampling results continue to exceed comparison values and therefore will be evaluated further. Since beryllium is currently being detected off site, a future completed pathway is expected to exist.

Concentrations of chromium which exceed the CREG comparison value were detected off-site (station R-1) during the July 1991 RCRA ambient air sampling program. Based on that 5-week period of sampling data, which indicates a past completed pathway, ATSDR believes that exposures to chromium in the air are presently occurring and are likely to occur in the future.

Inhalation is the only route of exposure that is considered by this pathway. Past and current exposures to concentrations of beryllium and chromium, which exceed comparison values, have occurred within 2 miles of NGK, so potentially a population of less than 14,686 has been exposed (4).

Off-site Soil

Forty-nine surface soil samples collected on public and private property around the NGK facility revealed total beryllium concentrations that exceed the Cancer Risk Evaluation Guide comparison value (0.2 mg/kg). Total beryllium was detected at a maximum concentration of 6.9 mg/kg and soluble beryllium at 0.0054 mg/kg (11,14). Concentrations of total chromium, also sampled on public and private property, exceed the pica child's RMEG comparison value for hexavalent chromium (but not for trivalent chromium) in 48 samples, with a maximum concentration of 92.6 mg/kg. None of the samples exceeded ATSDR's hexavalent chromium RMEG for non-pica children or adults. Samples were collected in both upwind and downwind locations of NGK (26).

No samples considered to be appropriate for background reference were collected for the area. Beryllium is a naturally occurring metal in the earth's crust, and beryllium studies of background soil in the eastern United States range up to 7 mg/kg (27,28,29). Such background soil studies indicate that beryllium exists in the soil (surface soil and otherwise) and are used by ATSDR throughout this document as representing concentrations that could exist for this particular area. Local soil background information would be needed to more accurately assess off-site soil conditions and potential site-related impacts.

Chromium is also a naturally occurring element. Chromium concentrations have been detected up to 1000 mg/kg in background studies in the eastern United States (28,29).

Although NGK is an apparent contributing source of beryllium in the soil surrounding the site, from data reviewed it cannot be definitively determined to what degree NGK has contributed to off-site contamination. Fugitive dust and deposition of air emissions are possible pathways of off-site migration. Off-site chromium impacts from NGK, however, are less apparent. Regardless of the source or sources of beryllium and chromium in the soil surrounding NGK, ATSDR will evaluate this off-site exposure pathway and the concentrations detected in surface soil.

A completed pathway exists for people who live, work, and recreate in areas located within two miles of NGK. The greatest opportunity for exposure in surface soil would be at residential lawns, parks, playgrounds, gardens, and worksites where excavation occurs. Since beryllium was detected at the residence where private well 1 is located, ATSDR will consider the possibility of impacts on that family from multiple exposure pathways. Dermal contact and inadvertent ingestion of soil are the likely routes of exposure. Inhalation of beryllium is a less likely route, but could have occurred if excavation of soil and ground cover generated significant amounts of dust. An accurate estimate of this population cannot be determined; however, 14,686 people live within a 2-mile radius of the site.

B. Potential Exposure Pathways

A list of potential exposure pathways is located in Table 12 of Appendix B.

On-site Soil

There are past, present, and future potentially completed pathways through on-site soil. On-site workers could have been exposed to contaminants in the past during removal and disposal of process wastes or when working at waste disposal areas prior to their having been covered. Also, area residents who entered the site property prior to fencing could have come in contact with on-site wastes. On-site workers could presently (or in the future) be exposed to contaminants when working in or around the Disposal Area Drain Field which is currently uncovered. Nearby residents also may have been exposed to contaminants through dust created by excavation and/or wind erosion. Potentially, future exposures could occur to workers and the surrounding community during remediation, when waste areas will be excavated and combined, if protective measures are not taken to prevent migration of site contaminants.

Routes of exposure would include dermal contact, inadvertent ingestion of contaminated soil, and inhalation of airborne contaminants. The number of people potentially exposed to contaminants in the past is not known. Currently 4,927 people reside within 1 mile of the site and NGK employs approximately 100 people. Current and former workers and residents who have been on-site would represent the potential receptor population.

Off-site Groundwater

Private well 3 did not show any contaminants above comparison values. But beryllium, which was detected at elevated levels in other off-site wells, was analyzed using detection limits that are above current comparison values (15). Exposures could potentially occur for people using this well or other wells further west of the EPA specified well inventory area.

Groundwater from the off-site monitoring wells, piezometer, and Reading Crest Well showed contaminants that exceeded comparison values, but the groundwater has not been used for consumption or other domestic purposes. Based on sampling, exposure could result if any of those wells are used in the future for consumptive or domestic purposes. Also, based on off-site groundwater sampling, it appears that any wells placed within the EPA specified well inventory area might be susceptible to contamination. Therefore, the construction of wells or the use of groundwater supplied by wells placed within the EPA specified well inventory area should be restricted to prevent future exposures.

People using private well 3, and current or future users of groundwater within the EPA specified well inventory area and west of that inventory area extending to the Schuylkill River, could potentially be exposed to contaminants. Routes of exposure include ingestion (i.e., drinking water or eating foods cooked in water), dermal contact (i.e., bathing, showering, or washing dishes), and inhalation (volatile organic vapors from showering, laundering, sprinkling the lawn, and washing automobiles). The number of people who could potentially be exposed cannot be determined.

Off-site Sediment

There is no evidence that current exposure to Laurel Run sediment is occurring, although there is a potential for past, present, and future exposures, primarily for children, who would be most inclined to play in Laurel Run. Sediment exposures may also have resulted from fishing and bait collecting in Laurel Run.

Although some residents have reported that Laurel Run has been dredged in the past, there is no information indicating that sediments have ever been used in areas where greater potential for exposure could occur (e.g., sandboxes, volleyball lots, picnic areas).

Exposure could occur through dermal contact and inadvertent ingestion through splashing of water and sediment and hand to mouth activities. ATSDR believes that exposure to contaminated sediments from Laurel Run would be minimal, due to the infrequent opportunities for exposure, low probability of contact, and low doses of contaminated sediment that might be received. Even children with pica behavior (excessive ingestion of nonfood items) do not typically directly ingest stream sediment. The number of persons that might have been exposed to contaminated sediment is not known.

Off-site Surface Water

There is potential for past, present, and future exposures to contaminated surface water. Children living near Laurel Run, fishermen, and other stream users are the most likely receptors. Direct exposure to NGK wastewater discharge is very unlikely. Water from Laurel Run is not used as a public drinking water supply and there are no allegations or documentation of its use by individuals for consumption. Due to dilution of surface water and the settling out of contaminants, drinking water supply obtained from the Schuylkill River, downstream from Laurel Run, is unlikely to be significantly affected by pollution from Laurel Run alone. Other sources may also contribute to water quality problems in the Schuylkill River.

Surface water exposure routes would include incidental ingestion and dermal contact. The number of persons that might have been exposed to contaminated surface water is not known.

Off-site Biota

Biota near NGK and along Laurel Run might potentially have been and continue to be contaminated with those contaminants detected in ambient air, groundwater, surface water, and sediment. Biota may come in contact with and accumulate contaminants from their surrounding media (air, water, sediment), although some metals such as beryllium and copper are not readily bioconcentrated (27,30). People have reportedly eaten fish (notably Suckers) caught from Laurel Run, downstream of NGK. Humans may also be exposed through the consumption of terrestrial plants or animals that have been grown or raised in contaminated areas (nearby residential yards and along Laurel Run).

There is past, present, and future potential for exposure, via ingestion of biota that may be contaminated with metals from the site. The number of people who may have consumed such contaminated food cannot be determined.

Workers' Clothing

A potential past completed pathway exists for the families of workers who were exposed to beryllium. In the past, plant workers were not required to wear protective clothing and thereby accumulated contaminants on their clothing. Contaminants carried home by workers may have resulted in exposures to family members. Family members, particularly through laundering contaminated work clothes, could have been exposed through inhalation, ingestion, and dermal contact. Current safety measures and protective clothing should reduce the opportunity for any present or future exposures of this type to occur.

There are no data or information to determine what levels of contaminants people may have been exposed. The number of people who may have been exposed through this pathway in the past in not known.

PUBLIC HEALTH IMPLICATIONS

A. Toxicological Evaluation

In this section, ATSDR discusses health effects that could result from exposures to site contaminants. People can only develop health effects from a site contaminant if they come in contact with it; therefore, only contaminants present in completed pathways will be evaluated. In order to understand health effects that may be caused by a specific chemical, three factors affecting how the human body responds to exposure need to be considered. These factors include the exposure concentration (how much), the duration of exposure (how long), and the route of exposure (breathing, eating, drinking or skin contact). Lifestyle can affect exposure duration and likelihood. Individual characteristics of each human such as age, sex, nutritional status, overall health, and genetic predisposition can affect how a contaminant is absorbed, distributed, metabolized or eliminated from the body. Together, these factors determine the individual's response to chemical contaminants and what the health effects may be for that individual. Health effects from dermal absorption of compounds in water are hard to evaluate because they depend on length of exposure, exposed skin area, and frequency of washing, as well as properties of the chemical and how well it is absorbed across the skin.

ATSDR examines scientific studies and reports for individual contaminants (including those collected in the ATSDR Toxicological Profiles series). ATSDR uses those data to evaluate the potential for chemicals to cause harm to human health and determines levels of the chemical that can reasonably (and conservatively) be considered as harmless. That information has been incorporated (with safety factors to ensure protection of especially sensitive populations) into guidelines that can be used to identify chemicals of concern for further evaluation. ATSDR uses two kinds of guidelines as comparison values, environmental guidelines and health guidelines. The environmental guidelines can be used to determine if an environmental concentration of a compound is sufficient to merit further study. Such environmental guidelines include the Cancer Risk Evaluation Guides (CREGs), Environmental Media Evaluation Guides (EMEGs), Reference Dose Media Evaluation Guides (RMEGs), and other guidelines used in the tables in Appendix B of this document. The health guidelines include the Minimal Risk Levels (MRLs) and Reference Doses (RfDs). In this case, an estimate is made of the dose people are likely to receive from contaminants at the site, and this value is compared to the health guidelines. The health guidelines are specific for various segments of the population (adult, child, pica child) and for either cancer or non-cancer effects. In some cases, ATSDR has been unable to determine the values for use as guidelines due to lack of scientific data.

It must be emphasized that ATSDR's comparison values are not thresholds of toxicity. They were specifically designed to be protective of public health rather than predictive of adverse health effects. Thus, if a given concentration of an environmental contaminant is lower than the appropriate comparison value, that concentration of the specific chemical in the specific medium may reasonably (and conservatively) be considered safe. However, the fact that the concentration of a chemical exceeds a given comparison value does not necessarily imply that it is likely to produce adverse health effects of any kind. The conditions of exposure and individual susceptibility factors will determine whether or not the intrinsic toxic potential of a chemical is likely to be expressed. That is why contaminants of concern, identified by application of ATSDR's comparison values, are subsequently subjected to further analysis by ATSDR's toxicologists.

A description of the types of ATSDR and other comparison guidelines used can be found in Appendix C.

Some chemicals were found at elevated levels in various environmental media, but there were no completed pathways of human exposure for these chemicals. These included arsenic, copper, lead, antimony, barium, cadmium, manganese, nickel, selenium, thallium, vanadium, nitrate, and 1,1,1-trichloroethane.

Some chemicals were found at elevated levels within completed pathways, but were not at high enough concentrations to be a health concern when likely human doses were considered. These included fluoride, tetrachloroethene, and trichloroethene. In some cases, ATSDR lacks information to evaluate the potential carcinogenicity of these materials. Further, off-site soil, on-site air, and off-site air were not tested for many of these compounds. Beryllium, chromium, and 1,1-dichloroethene were also found at elevated levels within completed pathways and are discussed below in further detail.

Beryllium

Beryllium was found at elevated levels in on-site and off-site groundwater, on-site and off-site soils, on-site and off-site air, and in the water and sediment of Laurel Run.

Beryllium is used in strengthening alloys, primarily of copper, but also aluminum and nickel; it is used in alloys for fatigue resistance, corrosion resistance, and insulation. The major environmental source is combustion of coal. Beryllium can leach from soils and enter groundwater, but only to a limited extent as it is relatively insoluble and binds tightly to soils. Occupational exposure has occurred in mines and factories making alloys and products. Cigarette smoking can also be a major source of beryllium exposure.

Inhalation Exposure

Beryllium is scientifically recognized as a health problem, primarily by inhalation. Exposure through the inhalation route, via the air pathway, is the primary route for beryllium to cause health effects. Acute exposure by inhalation can cause inflammation of the lungs, with chest tightness, coughing, and fatigue, but eliminating acute exposure should result in restoration of the lungs to a normal state. Long-term exposure by inhalation can result in shortness of breath and some scarring of the lung, leading to chronic beryllium disease (CBD). Symptoms of CBD include shortness of breath, fatigue, weight loss, chest and joint pains, cough, and skin rashes.

Diagnosed cases of both acute and chronic beryllium disease have been extremely rare in recent decades. As of 1983, no cases of occupational berylliosis had been reported among individuals first exposed after 1973. With only one exception, no cases of CBD have been reported from indirect or nonoccupational exposure among individuals whose exposure began after about 1950 (31,32). However, since CBD mimics the symptoms of sarcoidosis and may readily be confused with the latter disease, it is possible that additional, undiagnosed cases of CBD, masquerading as sarcoidosis, have occurred. CBD involves a cell-mediated immune response to beryllium exposure which appears to express itself primarily in people with a genetically-determined susceptibility for the disease. This fact has led to the development of the beryllium lymphocyte transformation (or proliferation) test which can distinguish between sarcoidosis and CBD (33). This test may be performed on a blood sample, but results are more reliable when performed using bronchiolar/alveolar lavage fluid. Corticosteroids, which are often prescribed for CBD, may interfere with the test.

By the inhalation route, some beryllium compounds (both soluble and insoluble forms) have been shown to increase the incidence of lung cancer in laboratory animals (27). Human evidence is more equivocal, however, since most of the positive studies have been inadequately controlled for confounding factors such as smoking. (Heavy smokers have a 10-20-fold increased risk of getting lung cancer. In addition, cigarettes contain approximately 0.5 - 0.7 μg Be/cigarette, some 4.5 - 10% of which escapes with the smoke. For a 2-pack-a-day smoker, the resulting intake of beryllium could be comparable to the dose that would result from breathing 0.01 $\mu g/m^3$ for 24 hours a day. Thus, it is essential in an epidemiological study of beryllium and lung cancer that the results be controlled for smoking habits.) Currently, EPA considers the epidemiological evidence for beryllium-induced lung cancer in humans to be "inadequate". Where an excess of lung cancer has been detected, it has been more prevalent among workers with acute beryllium disease (i.e., chemical pneumonitis) than those with CBD (27). Historical health outcome data strongly suggest that implementation of OSHA's Permissible Exposure Limit (PEL) has effectively prevented the occurrence of new cases of beryllium lung disease which could possibly be a precursor of Beryllium-induced lung cancer, i.e., <u>if</u> beryllium is, in fact, carcinogenic in humans (32). In this connection, it is worth noting that OSHA's PEL of 2 $\mu g/m^3$ is 5,000 times higher than

ATSDR's CREG of 0.0004 $\mu g/m^3$, while the NESHAPs regulatory limit of 0.01 $\mu g/m^3$ is only 25 times higher than ATSDR's CREG.

On-site and off-site ambient air contained beryllium. Based on ambient air data in Table 9, concentrations of beryllium have exceeded the CREG comparison value at all of the 8 monitoring stations in the past and in 1994 exceeded the comparison value at each of the eight stations. In an earlier draft of this document, it was stated that "a slightly increased risk of cancer might be expected" if someone were exposed for an entire lifetime to beryllium at the highest concentration detected in off-site air. However, considering the low confidence attached to the study on which EPA based its classification of beryllium's carcinogenicity, and the generally low concentrations of beryllium in off-site air at this site, ATSDR does not expect any increased risk of lung cancer in nonoccupationally-exposed residents. As indicated by the preceding discussion, it may be of greater relevance to human health that the NESHAP's limit of 0.01 $\mu g/m^3$, defined as a 30-day average, has only been exceeded twice (both times in 1989) in the last 16 years. On-site air data are limited in scope, representing five weeks in 1991 (Table 10). At that time, levels were insufficient to pose a health problem. Off-site data were taken for a number of years at various stations around the site. These values represent weekly concentrations. The highest concentration was observed in 1989 at station R-1 (Table 9), which was located very near the plant and downwind. This concentration (0.08143 $\mu g/m^3$) did exceed ATSDR's CREG of 0.0004 $\mu g/m^3$. However, this concentration was present for only a short time period (CREGs assume lifetime exposure) and this limited exposure is believed by ATSDR to represent no health hazard. Since levels at other sampling points and during all other time periods were significantly lower and of similarly limited duration, ATSDR considers these levels also to represent no public health hazard. Generally, levels off-site have been decreasing in recent years. In the judgement of ATSDR, if any adverse health effects occurred in response to higher off-site exposures in the past, they would probably be limited to CBD in a sensitive (i.e., immunologically predisposed) subpopulation living near the site. Since any past cases of nonoccupational CBD would likely have been misdiagnosed as sarcoidosis, long-term residents who have been diagnosed as having sarcoidosis and who suspect that they may have been exposed to clinically significant levels of beryllium in the past may want to consider consulting an occupational/environmental medicine specialist who can determine whether specialized testing for beryllium sensitivity is appropriate.

Ingestion Exposure

Beryllium metal does not cause disease by ingestion, because it is unable to cross the gut wall and enter the tissues of the body (27,34). Some beryllium salts are more soluble, but are still not absorbed well. The more soluble beryllium salts (such as beryllium fluoride) react in the gut and form insoluble complexes with phosphates and proteins that are not well absorbed (35,36). Beryllium has not been found to cause cancer by the oral route in either animals or humans (27). EPA's oral cancer slope factor and ATSDR's CREGs for beryllium

in soil and drinking water were derived from a single laboratory study that showed a statistically non-significant increase in total tumor incidence in rats (males only) exposed chronically to 0.7 mg Be/kg/day as beryllium sulfate in drinking water (27,37). This study does not, however, provide evidence that beryllium is carcinogenic via the ingestion route. The incidence of cancer did not increase with increasing dose. In another chronic study, rats exposed to 31 mg Be/kg/day as beryllium sulfate in feed exhibited no adverse health effects, including cancer (38). There is no evidence that beryllium can cause cancer in humans by the ingestion route.

Off-site groundwater was contaminated with elevated levels of beryllium. However, based on cancer and other health guidelines, levels in groundwater were not considered sufficient to cause any acute or long term effects, including cancer. The maximum concentration of beryllium in off-site groundwater was 5.3 μg/L, which is only 32% higher than the MCL of 4 μg/L. The MCL is not a strictly health-based criterion, and is mentioned here only for the purpose of comparison.

Beryllium levels in off-site soils were within the range expected for background levels in soil, which range from <1 to 7 mg/kg, with an average of about 0.85 mg/kg (28,29). Therefore, this result may represent a background level rather than the result of migration of contamination from the site. Further, the beryllium may be tightly associated with the soil particles and may not separate from the soil to enter the body (low bioavailability). Although it is not known what form of beryllium may be predominant in the soil, it is known that insoluble forms, such as beryllium oxide, are most commonly found in ambient air and those forms of beryllium generally remain insoluble and immobile when deposited into the soil and sediment (27). Total beryllium was detected in off-site surface soil at a maximum concentration of 6.9 mg/kg which exceeds ATSDR's CREG of 0.2 mg/kg, but is under the RMEGs of 10, 300, and 4000 mg/kg for pica child, child, and adult, respectively. Soluble beryllium was detected at a maximum concentration of 0.0054 mg/kg, which does not exceed any comparison values. Since beryllium does not readily cause disease by ingestion, the concentrations of beryllium detected in soil and drinking water are not expected to pose any hazard to public health.

Dermal Exposure

Beryllium may also act as a direct irritant on the skin, nasal passages, and in the lung. Symptoms are not specific, but redness of the skin, opacity in the eye, coughing and chest tightness may result. The irritation may invoke an immunological (allergic) response, especially in genetically predisposed individuals, and may be worse in individuals previously exposed to beryllium. High levels of exposure via direct contact with beryllium may even lead to ulcers on the skin (27). However, based upon data reviewed by ATSDR, the levels measured in environmental media do not represent a public health hazard via dermal exposure.

Chromium

Only the trivalent and hexavalent forms of chromium are of any biological significance. Trivalent chromium (Cr^{3+}), the most common form of chromium, is an essential trace nutrient required for the proper function of several enzyme systems, including the glucose tolerance factor, phosphoglucomutase, and the succinate, cytochrome C reductase system (39). Cr^{3+} is neither irritating nor corrosive, and chronic inhalation or ingestion of Cr^{3+} compounds produce no adverse health effects. Trivalent chromium compounds have not been reported as carcinogenic by any route of administration. Normal levels of blood Cr range from 20 to 30 μg/dL (evenly distributed between RBCs and plasma), and urinary excretion is generally less than 10 μg/day (40).

Hexavalent chromium (Cr^{6+}), the most toxic form of chromium, readily crosses cell membranes and is reduced intracellularly to Cr^{3+} (there is no evidence that the reverse reaction occurs to any significant extent) (39). Long-term inhalation exposure to insoluble Cr^{6+} compounds is associated with irritation and corrosion of the mucosa and submucosa of the respiratory tract, which may lead to ulceration and perforation of the nasal septum. Other skin surfaces may also become ulcerated. Occupational inhalation exposure to chromium, particularly in the chrome production and chrome pigment industries, is associated with an excess incidence of lung cancer. However, hexavalent chromium compounds have not produced lung tumors in animals by inhalation.

Nonoccupational exposure to chromium is primarily through ingestion of food (especially meat, vegetables, and unrefined sugar) and water (MCL = 100 μg Cr^{6+}/L) (40). Acute renal tubular necrosis is the major acute effect of ingestion exposure to chromium (39). However, tissues can accumulate considerable quantities of chromium before pathological changes result. EPA's chronic oral RfD of 0.005 mg Cr^{6+}/kg/day includes an uncertainty factor of 500, [i.e., it is 500 times lower than the no observed adverse effect level (NOAEL = 2.4 mg/kg/day)] determined in an animal study (41). No adverse health effects were detected by physical examination in a family of four persons who drank for 3 years from a private well containing Cr^{6+} at approximately 1 mg/L, or 1,000 μg/L (approximately 0.029 mg/kg/day in a 70-kg human) (42). While hexavalent chromium is considered to be a human carcinogen when inhaled, it is not thought to be a carcinogen in animals or humans when ingested in water (43).

Although private well 1 did have elevated quantities of chromium (Table 4a), ATSDR inaccurately concluded, in the previous draft of this document, that consumption of water from that well could cause "potential acute health effects". The maximum level detected was 281 μg/L Cr^{6+} (estimated value). The corresponding dose for a 70 kg adult drinking 2 liters of water per day would be 0.008 mg/kg/day which is marginally (60%) higher than EPA's RfD of 0.005 mg/kg/day for a lifetime (70 years) of exposure. Private well 1 was only used for eight years; therefore, no adverse health effects would be expected. The residents at that

location were provided with an alternative water supply in 1991, thereby eliminating the possibility of excess exposure in the future.

Past and current levels of chromium detected in private well 2 are not expected to result in any adverse health effects; however, monitoring for increasing concentrations is advised.

Volatile Organic Compounds (VOCs)

The volatile organic, 1,1-dichloroethene (DCE), was present in private well 1 at levels that exceeded ATSDR's CREG of 0.06 μg/L. EPA classifies 1,1-DCE as a "possible human carcinogen" based on limited animal data and no data in humans. Based on that fact alone, it was stated in an earlier draft of this document that the levels of DCE in private well #1 "pose a slight increased risk of cancer". However, based on a more complete evaluation of the level and duration of exposure, and on a consideration of the basis for the cancer classification of DCE, ATSDR no longer considers this statement to be appropriate. Both EPA's classification of DCE and ATSDR's CREG are based on an animal study which showed a statistically insignificant increase of cancer (i.e., pheochromocytoma) in treated rats compared to controls. In that experiment, male rats were dosed by gavage with 5 mg DCE/kg/day for 2 years (i.e., most of a rat's lifetime). By comparison, the maximum level of DCE detected in private well 1 (i.e., 2 μg/L) would correspond to a dose (based on consumption of 2 L/day by a 70 kg adult) of 0.000057 mg/kg/day, i.e., 87,500 times lower than that in the animal study mentioned above. Even the maximum level of DCE detected in private well 1 was far below ATSDR's RMEGs of 90 and 300 μg DCE/L for children and adults, respectively. Therefore, no cancer or noncancer health effects from exposure to DCE would be expected at the concentrations found in private well 1. Private well 1 is no longer used (44).

B. Health Outcome Data Evaluation

The Commonwealth of Pennsylvania maintains a cancer registry (45). Three years of the registry (1984, 1985, and 1986) were examined for incidence or mortality rate of cancer in general and for lung cancer. Berks County showed no significant increases in cancer incidence or deaths from cancer in general or from lung cancer. However, the cancer registry is new, containing data collected during the last nine years. This database could reflect the consequences of chronic exposures beginning 20 to 30 years earlier, thereby taking into account the long latency period of some chemically-induced cancers. However, such a narrow "snapshot in time" (i.e., the last 9 years) cannot reveal any trends in cancer incidence in this area over the 60 year life of the NGK facility.

ATSDR also examined cancer records on the Centers for Disease Control WONDER computer database. No increases were found in the rate of any cancer type or in all cancer totals, when compared to the rates for the entire state of Pennsylvania, for white males or

females. The data for minority populations were limited by small numbers and could not be analyzed. Besides community health concerns, no other sources of health information relevant to the site were identified.

C. Community Health Concerns Evaluation

1. The chemicals (chromium and fluoride) found in local private drinking water well might cause cancer.

Chromium may cause cancer when inhaled, but not when ingested in water (46). Levels in private well 1 exceeded ATSDR's RMEGs for children and adults. However, RMEGs are based on the assumption of exposure over an entire lifetime. Exposure over a much shorter time period would pose little or no threat to human health. Chromium acts as an irritant, and effects are most likely to be seen in sensitized individuals (possible effects are discussed in the Public Health Implications section). ATSDR does not expect any health problems to develop now that this water is no longer used. Fluoride was found in off-site groundwater at elevated levels but these are not high enough to cause health effects under the exposures that are likely to occur. Fluoride has two major effects: acutely, large amounts can be corrosive and irritating; smaller amounts over long periods of time may cause tooth mottling and skeletal degeneration. Fluoride does not appear to cause cancer. Fluoride, when it reacts with beryllium, forms beryllium fluoride, a more soluble form of beryllium that may make the beryllium more mobile in the environment.

The users of private well 1 were provided bottled water, and more recently, they were connected to the city water supply because of the levels of chromium in their well water. No other private wells contained sufficient chromium to present a health problem.

2. Contaminated On-site groundwater could contaminate local drinking water supplies.

The potential exists for future contamination of private wells within and west of the EPA specified well inventory area. The presence of fluoride may increase the soil and water mobility of beryllium. Groundwater monitoring should be conducted to ensure that contamination does not extend beyond the EPA specified well inventory area and that levels of contaminants in private well 2 do not increase. The Reading Crest Well has shown contamination, but has never been used as a drinking water supply.

3. Airborne dust from NGK's old wastewater treatment lagoons might cause medical problems.

The Disposal Area Drain Field is the only waste area on-site that has not been covered. No surface soil samples have been taken to characterize what contaminants might be present in the top 3 inches of that waste area or other potentially contaminated areas. Air monitoring

was conducted beside (see Figure 5 and 6) the Disposal Area Drain Field and the Former Pond 6 waste pile during the July 1991 RCRA ambient air sampling program. Based upon weather observations during that sampling program, it appears that beryllium from waste areas is impacting air quality. Results from those monitors are reported in Table 10 and additional discussion regarding the RCRA ambient air sampling program can be found in On-site and Off-site Contamination sections under "Ambient Air."

The data are insufficient to judge potential effects from the dusts arising at these sources. Overall off-site air has in the past frequently exceeded ATSDR's CREG for beryllium in air. However, based on available information, those concentrations have not been sustained long enough for adverse health effects to be expected.

4. Residents living in the Reading area may develop sarcoidosis from exposure to beryllium oxide.

Beryllium causes chronic beryllium disease (CBD), a *sarcoidosis-like condition*. Its symptoms mimic those of sarcoidosis, and it may even be misdiagnosed as sarcoidosis. The two diseases should not, however, be equated with one another. CBD is a granulomatous lung disease caused by a hyperactive, cell-mediated, immune response to chronic beryllium exposure. It appears to require a genetically-determined sensitivity that does not obey any predictable dose-response relationship. CBD is seen primarily in factory workers and miners; only rarely is it seen in residents near factories or mines, suggesting that a large dose is necessary for the condition to develop. However, the effects of long term, low dose exposures are unknown and may well result in disease, especially when exposure is punctuated with short term, episodic, high level releases. The amount of beryllium exposure needed to cause CBD is uncertain. It is possible that episodic releases of dust containing considerable amounts of beryllium could have taken place. CBD has a latency of several months to several years (disease usually develops 10-15 years after exposure). Symptoms include shortness of breath, fatigue, weight loss, chest and joint pains, cough, and skin rashes. CBD may or may not progress, but it does not spontaneously clear up. There has been only one documented nonoccupational case reported nationwide among individuals whose exposure began after about 1950 (27,31,34,).

Sarcoidosis is a chronic disease of unknown cause characterized by formation of nodules, especially in the lymph nodes, lungs, bones, and skin. Statistics on the incidence and prevalence of sarcoidosis are highly uncertain due to the relative rarity of this chronic disease, the variable severity of its symptoms, the potential for misdiagnosis, and non-representative nature of most study populations. It is clear, however, that the incidence of sarcoidosis in the U.S. is much higher in blacks than in whites. There is no sex predominance in the incidence of sarcoidosis worldwide, and, in caucasian populations, cases of sarcoidosis are almost equally divided between men and women. Although the disease has been reported to be 2-3 times as common among black females as black males, this finding

may only reflect the fact that most of the early studies were done in large urban hospitals where the majority of patients seeking medical attention for any ailment happened to be females, especially black females. The current concensus is that there is no predominance of sarcoidosis among women of any race (47). Of all the potential risk factors studied (i.e., genetic, racial, infectious, environmental, occupational, smoking, and presence of other disease), only genetics and possibly geography are well established risk factors for sarcoidosis.

Sarcoidosis is most common in young adults between the ages of 20-40, who live in rural areas. It is an immunologically based response to environmental contaminants, although the specific agents involved are unknown. Because CBD may easily be misdiagnosed as sarcoidosis, ATSDR has examined sarcoidosis as a potential site-related health effect. However, based on currently available data, ATSDR is unable to conclusively establish any clear relationship between the site and the identified cases of sarcoidosis. Any long-term residents who have been diagnosed as having sarcoidosis and who suspect that they may have been exposed to clinically significant levels of beryllium in the past may want to consider consulting an occupational/environmental medicine specialist to determine whether specialized testing for beryllium sensitivity is appropriate.

5. Untreated storm water runoff and treated wastewater from NGK that are discharged into Laurel Run could be having a detrimental effect on aquatic wildlife. Furthermore, the treated waste and untreated storm water that are discharged into Laurel Run may eventually reach Schuylkill River (via Laurel Run) and contaminate local water supplies down river.

Some surveys suggest there is little wildlife immediately downstream (19,21). However, more recent studies demonstrate that there is an active juvenile fish population downstream and the junction of the Schuylkill River with Laurel Run, is considered a good fishing spot (2,48). Laurel Run is contaminated near the site, but further downstream recovery occurs. Other facilities may have also impacted the water quality of Laurel Run. Levels of site contaminants in the water and sediments of Laurel Run were generally low, with respect to ATSDR comparison values. However, contaminant concentrations in water and sediment may be detrimental to aquatic wildlife. ATSDR is recommending fish tissue sampling to evaluate any health threat that may exist for people consuming fish from Laurel Run or its confluence with the Schuylkill River.

Due to dilution of surface water from Laurel Run by the much greater volume of water in the Schuylkill River, and the settling out of contaminants, drinking water supplies obtained from the Schuylkill River downstream from Laurel Run are unlikely to be significantly affected by pollution from Laurel Run alone. Other sources may also contribute to water quality problems in the Schuylkill River.

6. Some people may have contaminated private wells and may be unaware of contaminated groundwater. This may affect people who have summer homes and were not interviewed during the well survey.

Other than the wells identified in this report, no wells are known to be in use within the EPA designated well inventory area. All homes and businesses within the well inventory area were contacted by Dunn Geoscience Corporation and water supply sources were verified by homeowner/occupant or the Muhlenberg Township Authority. ATSDR believes that this well inventory has adequately identified private well users who live within the inventory area (2,5).

7. The Reading Crest Well water is contaminated, and attempts have been made in the past to bring the well into service. There is concern that the well may be brought on-line in the future.

To date, the Reading Crest Well has not been used as a public water supply. A memo, dated November 30, 1990, from the Muhlenberg Township Authority states that the Authority has no plans to develop the Reading Crest Well (49).

8. Laurel Run is impacted by contaminants in surface water from wastewater discharged from NGK. There is concern for the health of children who play in Laurel Run and persons who may have eaten or may currently be eating fish from Laurel Run or at the confluence of the Schuylkill River and Laurel Run.

There are no health outcome data to show whether the health of children who may be playing in Laurel Run or persons who may have eaten fish caught from Laurel Run are being affected. Although individuals have not been identified, there are potential pathways of exposure for people who may have eaten fish from Laurel Run and for people who may be using/playing in the stream. There are no fish tissue data available that might show contamination or allow ATSDR to evaluate possible health effects. The health effects of the primary contaminant of concern, beryllium, are usually the result of inhalation. In order to receive harmful doses of site-related contaminants from stream sediment, considerable quantities of sediment would have to be ingested, which is unlikely.

9. The present parameters for the NGK National Pollutant Discharge Elimination System (NPDES) permit are too high, and compliance for the new, more stringent, standards is not required until August 1993. The Pennsylvania Department of Environmental Resources (PADER) and EPA have delayed compliance deadlines several times already.

Those concerns are regulatory in nature and are to be addressed by the regulatory agencies, PADER and EPA, responsible for establishing those regulations and standards. ATSDR is

an agency of the U.S. Public Health Service that addresses the public health impact at hazardous waste sites. Through this petitioned public health assessment, ATSDR could become indirectly involved through its evaluation of surface water and sediment in Laurel Run. Although ATSDR does not have regulatory authority, the Agency would make recommendations to determine the source and to reduce contaminant levels or restrict access to Laurel Run, if ATSDR concluded that Laurel Run represented a public health threat. To date, ATSDR has not determined Laurel Run surface water to represent a public health threat, but is recommending sampling of sediment and fish for site-related contaminants to more fully evaluate those pathways.

10. Deposition from air emissions from the metal facility over its entire history has accumulated in homes and on lawns throughout the community. Such contamination is believed to have impacted the health of persons in the community in the past and could be a current and future health threat.

There are no health outcome data to show whether the health of people living around NGK have been affected. Based upon off-site soil and air data reviewed by ATSDR, soil concentrations do not appear to represent a past, current, or future public health threat and air concentrations do not represent an immediate past (within the last 15 years) or current public health hazard.

11. The analytical procedure used to analyze the concentration of beryllium from air monitoring conducted since 1979 is not measuring all forms of beryllium present in the sample, therefore, is not revealing the actual concentration of beryllium present in the air.

This concern is being addressed by EPA, as it relates to EPA's analytical procedures. If EPA determines that the analytical procedure is not revealing the actual concentration of beryllium present in ambient air, ATSDR will reassess the health threat based upon new data as it becomes available.

12. There are no air monitors due south of the NGK plant to detect the levels of beryllium in which the nearest residents (along Water Street) might be exposed.

On-site air monitoring was conducted, during July 1991, at two stations (RCRA 01 and RCRA 02) along NGK's southern property line (see Figure 5 and 6). Since the concentrations detected (see Table 10) are representative of on-site ambient air at the southern portion of the site, those concentrations are likely to be similar to concentrations along Water Street, which is just off-site (to the south). While the concentrations detected do not represent a health concern, only five weeks of data from those monitors were available for ATSDR's review.

13. People have developed brain tumors and lung cancers due to exposure from site-related contaminants.

Although their cause is unknown and multiple causes may exist, brain tumors have not been linked to beryllium exposures. Lung cancers may be caused by beryllium exposure, but lung cancer also has many other causes, especially smoking tobacco products. It is not known if a cause and effect relationship exists between a particular site-related contaminant, exposure, and brain tumors or lung cancer.

14. The community could be exposed to contaminants during remediation when the solid waste management units are consolidated.

The community could be exposed to contaminants during remediation, if actions are not taken to prevent off-site migration of contaminants. ATSDR has listed this as a potential pathway of exposure and is recommending that protective actions be taken to prevent exposures to on-site workers and the surrounding community.

15. What is beryllium poisoning and its symptoms? Once absorbed, where does it go?

The nature and signs of beryllium poisoning have been discussed in the Public Health Implications Section of this petitioned public health assessment.

16. Health conditions that were reported by citizens as having occurred or occurring in the community include: children with liver, heart problems, asthma, and allergies; cancers of various types; emphysema and general respiratory illnesses; berylliosis; Parkinson's disease; hodgkin's disease; brain tumors; myopathy; mottling of teeth; brittle bones; hair loss; rashes; irritation at night; lots of colds; and a degenerative condition resulting from the side effects of treatment for beryllium poisoning.

A variety of health complaints have been reported by the community. Those that are possibly related to site contaminants of concern have been discussed in the Public Health Implications section of this petitioned public health assessment.

17. Could a child with asthma be more susceptible to beryllium?

It is possible that beryllium dust, when inhaled, might trigger an asthmatic response from the physical irritation of the dust.

18. Dust carried home, from the beryllium plant, on worker's clothing may have resulted in illnesses.

Based on reports from previous employees, it appears that the potential existed for contaminants to have been carried from the plant on their work clothing. Therefore, potential exposures and illnesses could have occurred. Although this may have been a possibility in the past, it is NGK's current procedure to provide protective garments that are collected and to require showers and clean change of clothing at the end of each work day for those employees that might be exposed to beryllium.

19. Exposures may result from residential gardens, community parks, and playing fields.

As discussed in the Pathways Analyses section, there is the potential for exposures to contaminants that may have migrated to the above mentioned off site locations. Although ATSDR is not able to determine whether migration has resulted in contamination of those areas, concentrations detected in recent soil sampling (at the above mentioned locations) does not represent any public health threat.

20. Could contaminants in groundwater cause respiratory infections from showering or cause mottled teeth, stress fractures, and colic in children?

ATSDR has determined that water from heavily contaminated wells should not be used for drinking. However, none of these effects are likely from the levels of contamination present in the groundwater.

21. Work practices at the plant were very poor and dusty in the past.

A number of previous workers have described poor working conditions. This document will be referred to the National Institute for Occupational Safety and Health for investigation of work related health concerns.

22. Exposures may have occurred from going on site before the site was fenced or from fields or caverns where contamination was dumped.

ATSDR has no information regarding dumping in caverns or fields, with the exception of wastes that were piled on-site in the past. Since we do not know the exact time period that nearby residents were on-site, the areas on-site where people went, the activities that they engaged in while on-site, and the location and extent of contamination during those times, it would be difficult to determine whether exposures occurred or the likelihood of adverse health effects. However, it is possible for such exposures to have occurred in the past, before the site was fenced.

23. There are a lot of illnesses around the site, particularly in the Cherokee Ranch area.

ATSDR does not have any health outcome data that are specific to the Cherokee Ranch area alone. But ATSDR acknowledges that several people who attended ATSDR availability sessions made mention of illnesses in the Cherokee Ranch area. As discussed in the Health Outcome Data subsection, data for Berks County do not show a significant increase in cancer; however, limitations for that data do exist.

24. Possible health hazards such as digging at or around the site, contaminated off-site groundwater, and air violations have not been communicated to the public.

A large portion of the public surrounding the site was contacted about the site through the well survey conducted in 1991. EPA has released a document about the site for public comment and conducted a public meeting in 1992. Other activities have taken place, such as the ATSDR site visit and availability sessions, where communications with the public have taken place. However, ATSDR is not in the position to determine whether any or all of those activities have been adequate to communicate the possible hazards to the public, although ATSDR does believe that this document should aid in accomplishing that task.

25. Lake Ontalaunee, from which the City of Reading gets its water supply, is being contaminated with beryllium.

A private citizen provided ATSDR with a table from a report showing results from four lake sediment samples that were collected on October 7, 1985. The expressed concern was regarding beryllium, chromium, and copper that were detected in sediment. Beryllium ranged from 0.86 to 1.4 mg/kg, chromium from 19 to 25 mg/kg, and copper from 17 to 75.6 mg/kg. Of those contaminants, only beryllium exceeds comparison values. Based upon another report completed in August 1993, sediment was sampled for beryllium at five locations at the Lake, but was not detected at the detection limit of 2.0 mg/kg (50). The source or sources of beryllium in sediment at Lake Ontelaunee is unknown, but there does not appear to be any significant contribution from man-made sources since concentrations are within the range of background concentrations for the eastern United States. Beryllium is highly insoluble and is not expected to pose a public health threat by the ingestion route.

26. Further contamination may have resulted from floods on Laurel Run in the past and dredging conducted by the Army Corp of Engineers.

The spread of contaminants onto creek banks and stream front property may have occurred in the past as a result of flooding. However, based on the limited stream sediment samples taken to date, concentrations of contaminants were relatively low. Therefore, significant contamination is not thought to have occurred. However, further sampling of stream sediment have been recommended. The Army Corp of Engineers has completed various

work assignments on Laurel Run. ATSDR has not obtained any information indicating that sediments have been removed from Laurel Run.

27. Orange and green colored smoke that caused individuals to experience a burning sensation was emitted from plant stacks in the past. Also in the past, ash from the plant would deposit on automobiles and seemed to deteriorate paint.

ATSDR has no data to evaluate the health impact and concerns related to plant emissions prior to 1979. Beryllium could potentially cause a burning sensation in the nasal passages. No colored smoke or heavy ash have been associated with the site in recent years.

28. Water in Laurel Run turns strange colors when it rains. Could water from Laurel Run that was used on gardens in the past be a health concern?

ATSDR cannot confirm the reports of Laurel Run turning strange colors during storm events. Aside from loading of sediment in the water column and possibly petroleum products being washed from highways and businesses, ATSDR cannot provide any insight as to the change in color of Laurel Run water. In the past, depending on the extent of contamination, it may have been possible for contaminants in stream water to be transferred via irrigation to soil and food stuffs in gardens. Currently, however, contaminants detected in surface water at Laurel Run have been relatively low in concentration (see Tables 6a, 6b, and 6c). Therefore, significant contamination would not likely result from periodic watering of residential gardens from Laurel Run.

29. There is a concern that the RCRA Facility Investigation conducted by Dunn Geoscience Corporation and air monitoring data collected by NGK are not reliable sources of information.

ATSDR has prepared this document based on all the relevant, available data that ATSDR was able to obtain. Documents used are referenced and the information and data are assumed to be reliable and accurate. ATSDR attempts to indicate (in the Quality Assurance/Quality Control subsection) any questions, problems, or inconsistencies that are recognized when evaluating data. Besides those issues raised in the Quality Assurance/Quality Control subsection, ATSDR has no basis, from a technical standpoint, to disqualify any available data as unreliable and inaccurate. Further, it is not within ATSDR's purview to police data monitoring, collection, or reporting. However, ATSDR would make any necessary revisions to this document, if data used herein are found to be inaccurate.

30. Do elevated levels of CD4+ T cells in the lung or blood make people more susceptible to chronic beryllium disease? What is a normal CD4+ T cell count and what would be abnormally high? Should OSHA or ATSDR check the CD4+ T cell count of people who work at and live around beryllium alloy manufacturing facilities?

Is beryllium the antigen in chronic beryllium disease? Is it possible that sarcoidosis has been analyzed in cases that may actually be chronic beryllium disease? If beryllium shows up in a biopsy of lung tissue (dried) from a person diagnosed with sarcoidosis, at what concentration (ppm) would it be a questionable case of chronic beryllium disease?

CD4+ T cells may accumulate in the lungs in response to beryllium exposure. However, they remain a research tool and their significance, except as evidence of an immune response, is not clear. Therefore, CD4+ T cells would not clearly or absolutely indicate susceptiblity to CBD. A normal CD4+ T cell count should range from 900-2800 cells/microliter (51). Because of the many other factors that can affect the numbers and location of immunological cells, CD4+ T cells would be a poor indicator of beryllium exposure and therefore may be of little use to ATSDR and/or OSHA. ATSDR's Health Activities Recommendation Panel reviews each public health assessment to determine whether any further health follow up (such as biological sampling) is warranted. CBD is known to have an immunological component. Simple compounds of beryllium are too small to elicit an immune response; antibodies are formed in response to foreign proteins which are hundreds or thousands of times larger than simple molecules. Therefore, the ultimate antigen, which has not yet been identified, is probably some proteinaceous product to which beryllium is bound. Sarcoidosis is discussed more fully earlier in this subsection, under Community Health Concern number 4. As we state in that response, sarcoidosis presents similar signs as does beryllium disease, except for the demonstrable presence of beryllium in the lungs. Therefore, based on testing lung tissue for the presence of beryllium, sarcoidosis should not be confused with CBD. It is the demonstrated beryllium-immunosensitivity of alveolar lymphocytes, rather than simply the presence of beryllium in the lung at any particular concentration, that supports a diagnosis of CBD as opposed to sarcoidosis. Beryllium may be present in the lungs of exposed individuals in either the presence or absence of disease. If beryllium is actually found inside granulomas from a patient's lung, it is not unreasonable to infer that the beryllium itself may have been the initial stimulus for granuloma formation. Even then, however, a conclusive diagnosis of CBD would require the demonstration of actual beryllium sensitivity. Currently, the easiest way to diagnose CBD is to test for beryllium sensitivity in white cells from blood or bronchoalveolar lavage fluid.

31. Is anyone doing research on a connection between beryllium and brain tumors or arthritic conditions resulting from absorption and or ingestion of beryllium?

Brain tumors have never been associated with beryllium exposures and research on this topic is unlikely. Much research is being done to address the causes of arthritis, but we do not know if an association with beryllium is being examined.

CONCLUSIONS

1. The site has been classified as an Indeterminate Public Health Hazard, primarily due to the lack of past air (prior to 1979) and off-site groundwater (prior to 1990) data. Data needed to evaluate the significance of past air and drinking water exposure pathways can no longer be obtained.

2. Data and scientific information that are available lead ATSDR to believe that significant exposures are not likely to occur through: 1) on-site surface soil, 2) off-site surface soil (for site-related contaminants not already analyzed), 3) off-site groundwater (for site-related contaminants not already analyzed in private wells 2 & 3), 4) off-site biota, and 5) stream sediment (subsequent to unusual sediment found during September 1991). However, actual data for the above mentioned environmental media are necessary to confirm whether or not a public health threat may exist and is further basis for an Indeterminate Public Health Hazard classification.

3. Based upon the environmental and exposure data evaluated by ATSDR, concentrations of contaminants detected in air, water, soil, and sediment are not believed to represent any public health hazard.

4. A past and current completed exposure pathway exists for users of private well 2. However, based on the low level of chromium detected in the groundwater, no adverse health effects are expected. Since future exposures are likely, continual monitoring of that private well water or provision of an alternative water supply is advised.

5. Current scientific evidence indicates that some humans may have an immunological hypersensitivity to beryllium which could cause chronic beryllium disease to occur in those individuals at relatively low levels. Therefore, ATSDR advises that individuals who suspect they have been exposed to clinically significant levels of beryllium in the past through the inhalation pathway and are experiencing symptoms of shortness of breath, fatigue, weight loss, chest and joint pains, cough, and skin rashes should consider consulting an occupational/environmental medicine specialist to determine whether specialized testing for beryllium sensitivity is appropriate.

Data gaps or data inadequacies are data that are needed to adequately or more fully evaluate environmental contamination and human exposure. These data inadequacies will be listed, although some data are no longer available. Data inadequacies discovered by ATSDR during preparation of this petitioned public health assessment include the following:

a. On-site surface soil characterization (0-3" dry weight basis) has not been conducted to determine contamination at the Disposal Area Drain Field and areas around

presently covered solid waste management units where contaminants may have migrated during waste disposal.

b. Complete off-site groundwater characterization (for site-related contaminants) has not been conducted to determine the actual extent of the contaminant plume.

c. Some site-related contaminants were not analyzed for in groundwater samples at private wells 1, 2, and 3 (only private well 2 needs to be sampled, unless the groundwater plume is determined to extend outside of the EPA specified well inventory area; private well 1 is no longer in use and private well 3 is outside of the EPA well inventory area).

d. Local background beryllium soil sampling has not been conducted to assist in determining site-related impacts.

e. Dry weight samples were not conducted for the unusual sediment observed in Laurel Run on September 17, 1991. The unusual sediment may no longer be present for sampling.

f. Off-site biota samples have not been conducted for potentially contaminated food chains.

g. The CREG for beryllium in soil is currently well below background levels commonly found in the environment. No reliable data are available indicating that beryllium causes cancer by ingestion. However, further study is needed to determine whether some levels and forms of beryllium may pose a non-cancer health threat to humans by the ingestion route.

h. Comparison values are not available for lead in soil.

RECOMMENDATIONS

1. Sample on-site surface soil (0-3" depth), for all site-related contaminants, at the Disposal Area Drain Field and around other Solid Waste Management Units where contaminant migration may have occurred. Representative on-site surface soil sampling should also be conducted following remediation in order to evaluate the effectiveness of remedial activities and any future potential health threat, as well as establish a post-remedial baseline.

2. Conduct a representative number of surface soil samples in residential lawns, parks, and playgrounds in areas downwind of NGK. Samples should be analyzed for arsenic, cadmium, copper, and lead, which are on-site subsurface soil contaminants of concern.

3. Conduct an expanded water well inventory to include areas west of the current EPA specified well inventory area extending to the Schuylkill River to determine whether any groundwater wells are in use in areas where the contaminant plume may exist or migrate. The depth and use of any wells identified should be recorded and those wells that are being used and which might be contaminated should be analyzed. Groundwater samples should not be field filtered.

4. Sample private well 2 for site-related contaminants that have not already been analyzed to ensure that contaminant levels in groundwater are not a current public health threat. Ensure that users of private well 2 continue to receive safe drinking water in the future. Groundwater samples should not be field filtered.

5. Restrict NGK property, properties within the EPA specified well inventory area, and properties west of the EPA specified well inventory area extending to the Schuylkill River, from groundwater use until groundwater remediation or characterization is conducted or until some alternative action is taken to ensure the protection of public health from contaminated groundwater supplies.

6. Conduct current sediment samples to identify whether sediment in Laurel Run near NGK is showing elevated levels of metals. Sediment contaminants should be analyzed on a dry weight basis.

7. Conduct a representative number of fish tissue samples from Laurel Run at locations adjacent and downstream from NGK. Fillet samples should be analyzed for metals present in NGK's wastewater discharge.

8. Actions should be taken during NGK site remediation to protect on-site workers and prevent migration of contaminants. Ambient air monitoring during excavation and transport of on-site waste is also recommended.

9. ATSDR also recommends that the Pennsylvania State Tumor Registry continue to monitor for increases in the incidence of upper respiratory and lung cancer that may develop from past exposure to beryllium in the air.

HEALTH ACTIVITIES RECOMMENDED

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, the data and information developed in the NGK Metals Petitioned Public Health Assessment have been evaluated by the Health Activities Recommendations Panel (HARP).

Available air data indicate that off-site concentrations of beryllium are occurring at levels which are not normally expected to result in adverse health effects (chronic beryllium disease) in the general population. However, in rare cases, some humans have been shown to have a hypersensitivity to beryllium at low levels of exposure. Such hypersensitive responses appear to be dose-independent. The symptoms of chronic beryllium disease are similar to a relatively rare disease, sarcoidosis. Based upon five reported cases of sarcoidosis in the area and the difficulty of diagnosis of this disease, HARP recommends a case series or case studies to be considered for reported cases of sarcoidosis to be conducted through ATSDR's Division of Health Studies, and health professional and community education to be conducted through ATSDR's Division of Health Education.

Current scientific evidence suggests that beryllium is not carcinogenic by ingestion. Further study is needed to determine whether some levels and forms of beryllium may present non-cancer health effects from ingestion of beryllium and to determine accurate biomarkers of susceptibility to beryllium-related illnesses. Based on those data needs, HARP recommends further research into beryllium to be conducted through ATSDR's Division of Toxicology.

Based upon worker-related health concerns, HARP recommends that this petitioned public health assessment be referred to the National Institute for Occupational Safety and Health for investigation of those and other work related health concerns.

PUBLIC HEALTH ACTION PLAN

The purpose of the Public Health Action Plan is to ensure that this petitioned public health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment.

Actions Undertaken

1. ATSDR responded to a petition for a public health assessment (petitioned on December 7, 1990) by conducting a scoping visit on January 26, 1991. A site screening report was drafted and presented internally on February 6, 1991. A decision was made that a public health assessment was warranted and a letter was sent to the petitioner on May 30, 1991. The petitioned public health assessment process was initiated in June 1991. ATSDR staff met with the petitioner to discuss concerns and the petitioned public health assessment on February 3, 1993. The initial release petitioned public health assessment was sent out for EPA and state technical review on April 26, 1993. Additional community health concerns were gathered during availability sessions on June 8, 1993. The petitioned public health assessment was released for over 60 days of public comment on September 1, 1993. Public comments were addressed and further revisions to the assessment were made based upon public comments, additional data and information, and further toxicological research.

Actions Planned

1. As a health follow-up action, ATSDR will forward a copy of this petitioned public health assessment to the National Institute for Occupational Safety and Health for investigation of work related health concerns and issues.

2. ATSDR will be available to provide technical assistance to local, state, or federal agencies or offices that may seek assistance in carrying out actions recommended in this petitioned public health assessment.

3. The Division of Health Assessment and Consultation will use this petitioned public health assessment as an educational tool for the community to make them aware of the possible hazards present, the likelihood of exposure, and to assist the community in assessing possible adverse health outcomes associated with exposure to hazardous substances.

4. The Division of Health Assessment and Consultation will review new data as it becomes available for ATSDR's review and evaluation.

5. If any new data presented to ATSDR are found to be of public health concern, the Division of Health Assessment and Consultation will revise this petitioned public health assessment as appropriate.

In addition, ATSDR will collaborate with appropriate federal, state, and local agencies to pursue the implementation of the recommendations outlined in this petitioned public health assessment.

ATSDR will reevaluate and expand the Public Health Actions when needed. New environmental, toxicological, or health outcome data, or the results of implementing the above proposed actions, may determine the need for additional actions at this site.

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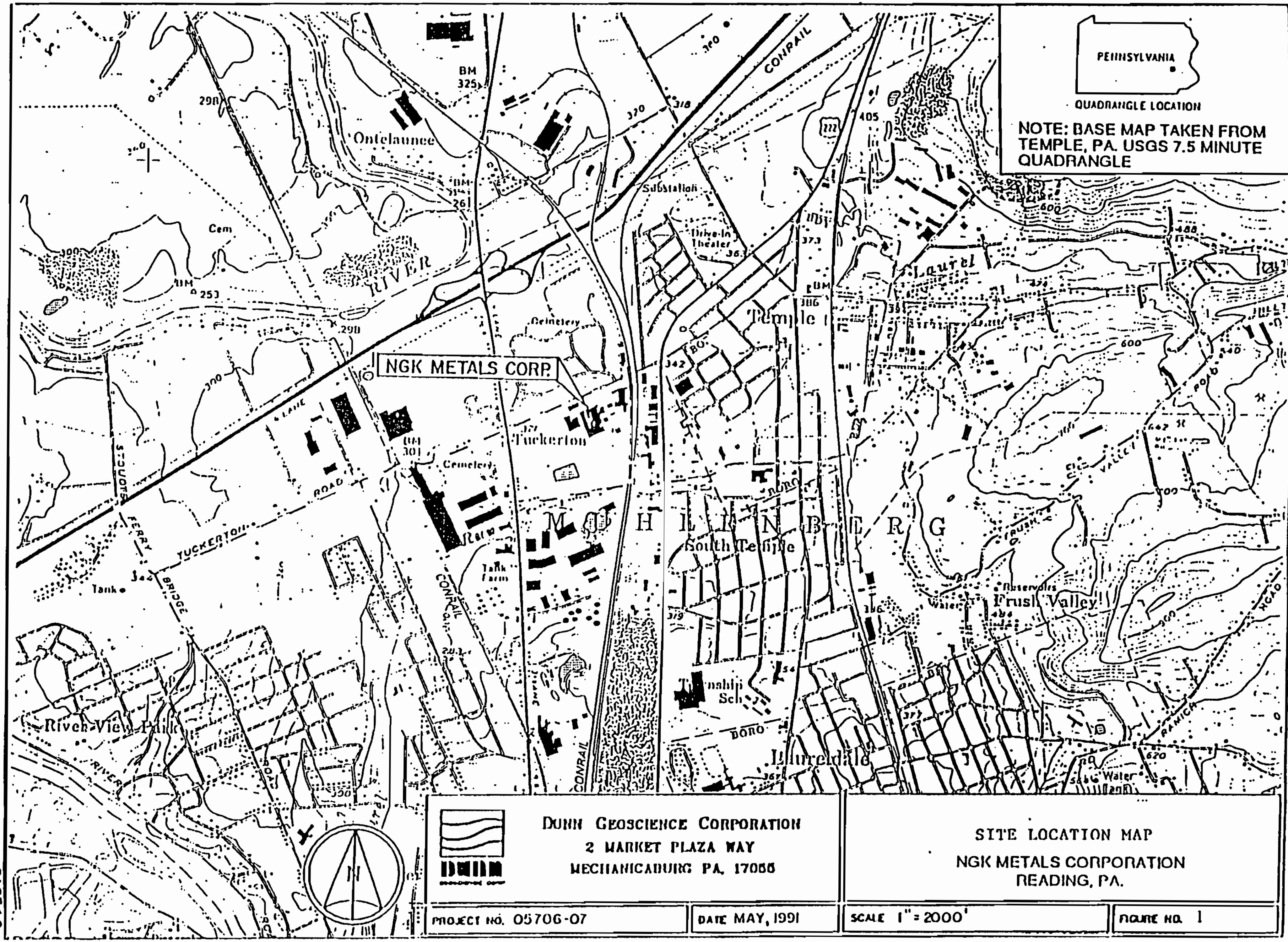
APPENDIX A


PENNSYLVANIA
QUADRANGLE LOCATION
NOTE: BASE MAP TAKEN FROM TEMPLE, PA. USGS 7.5 MINUTE QUADRANGLE
NGK METALS CORP.
CONRAIL
RIVER
Ontelaunee
Cem
Substation
Drive-In Theater
Laurel
Temple
Cemetery
Tuckerton
TUCKERTON
ROAD
FERRY
BRIDGE
Tank
Tank Farm
M U H L E N B E R G
South Temple
Reservoirs
Frush Valley
Water
River View Park
BORO
Laureldale
Water Tank
DUNN GEOSCIENCE CORPORATION
2 MARKET PLAZA WAY
MECHANICSBURG PA. 17055
SITE LOCATION MAP
NGK METALS CORPORATION
READING, PA.
PROJECT NO. 05706-07
DATE MAY, 1991
SCALE 1" = 2000'
FIGURE NO. 1
N

PAGE 1-2

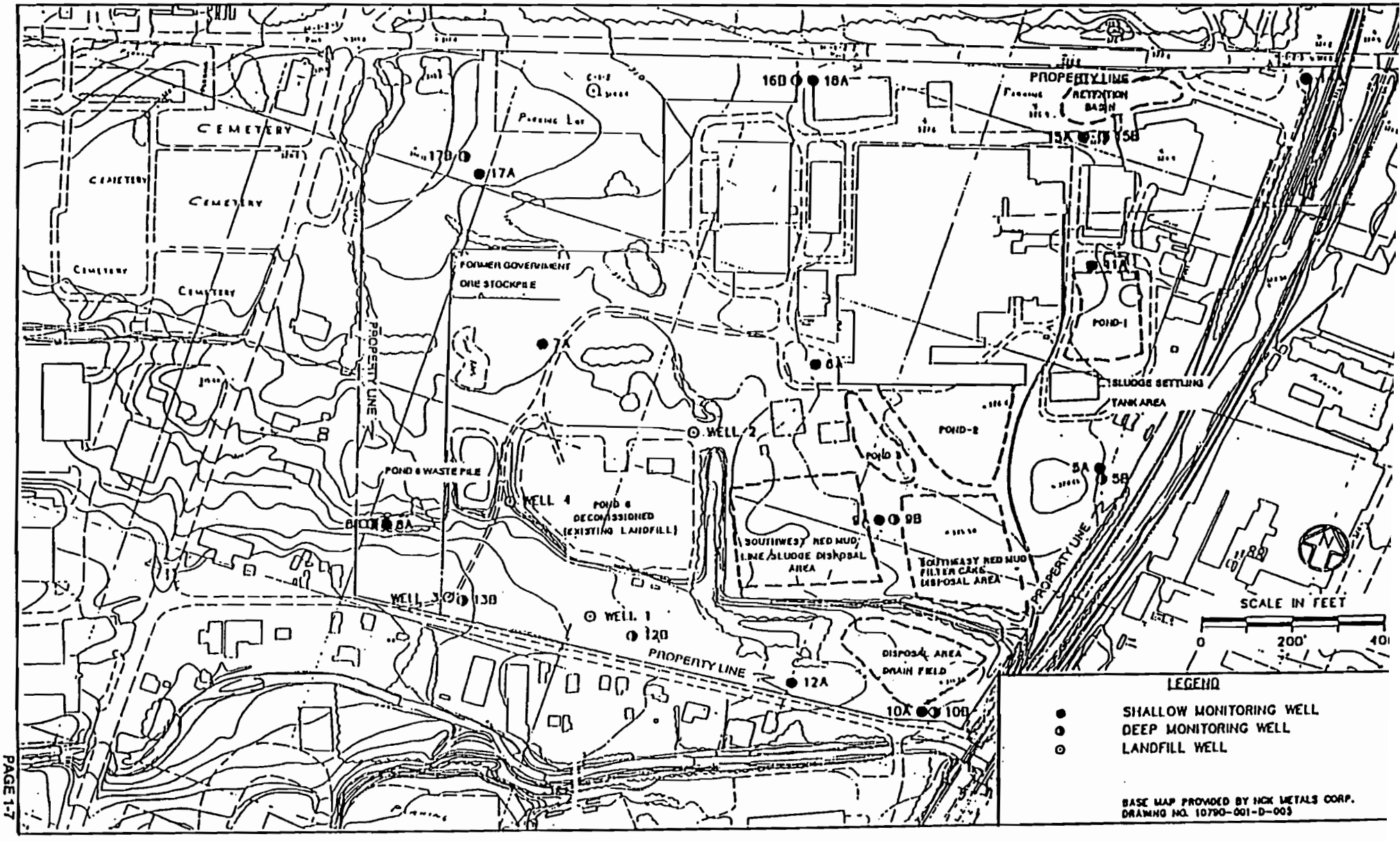
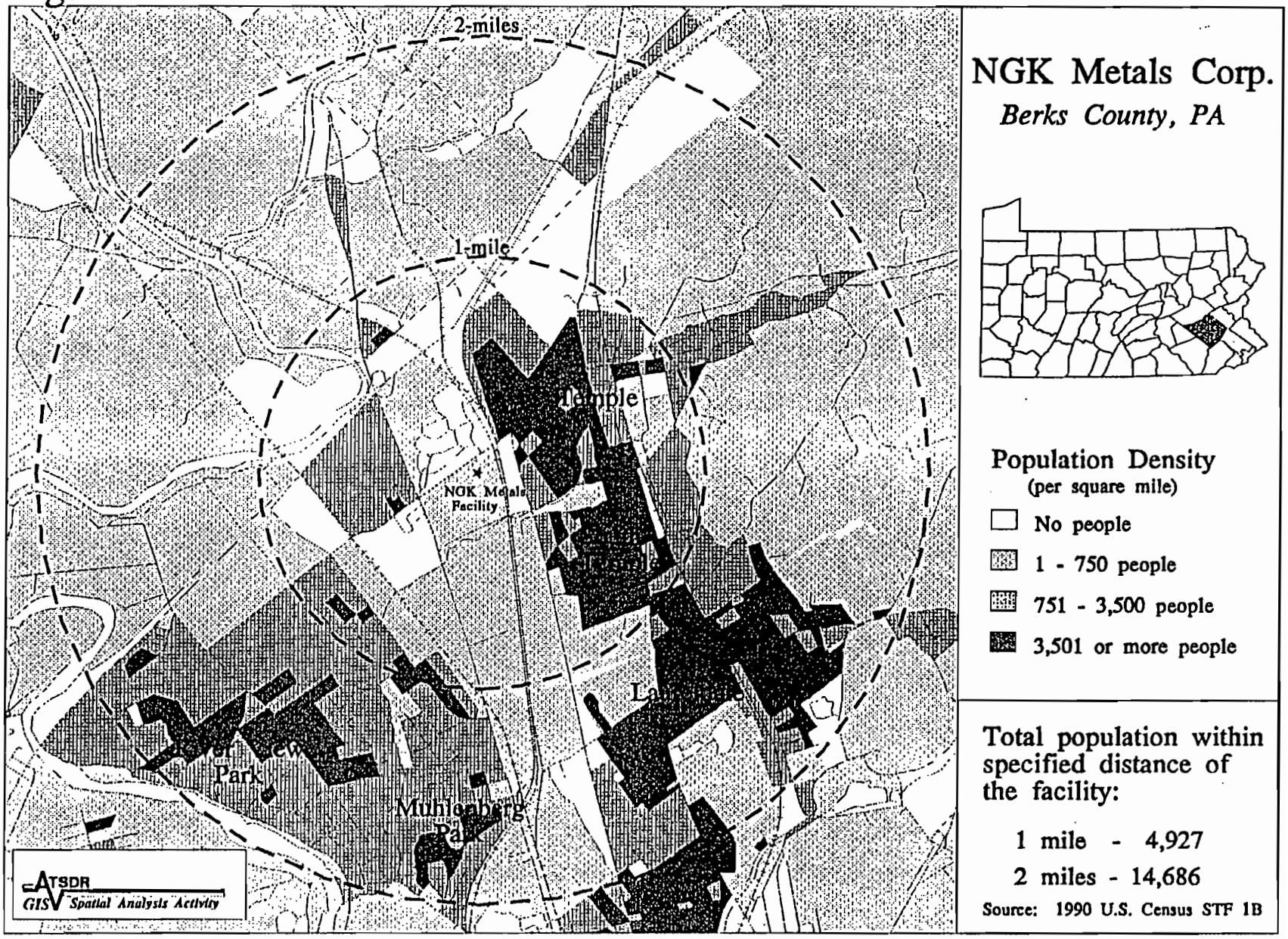


Figure 2
SWMU Map

Figure 3


2-miles
1-mile
Temple
NGK Metals
Facility
Muhlenberg
Park
ATSDR
GIS Spatial Analysis Activity
NGK Metals Corp.
Berks County, PA
Population Density
(per square mile)
No people
1 - 750 people
751 - 3,500 people
3,501 or more people
Total population within specified distance of the facility:
1 mile - 4,927
2 miles - 14,686
Source: 1990 U.S. Census STF 1B

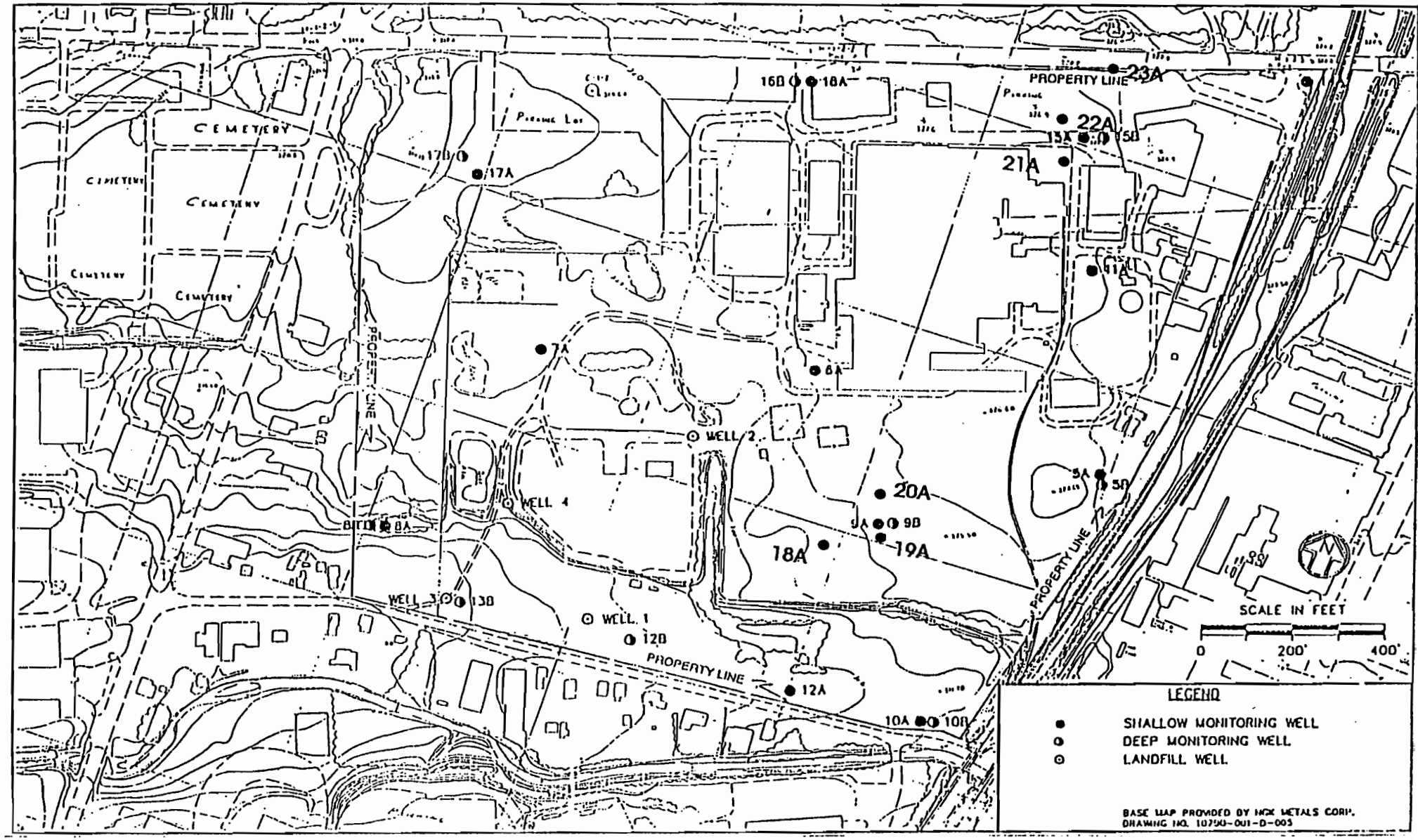
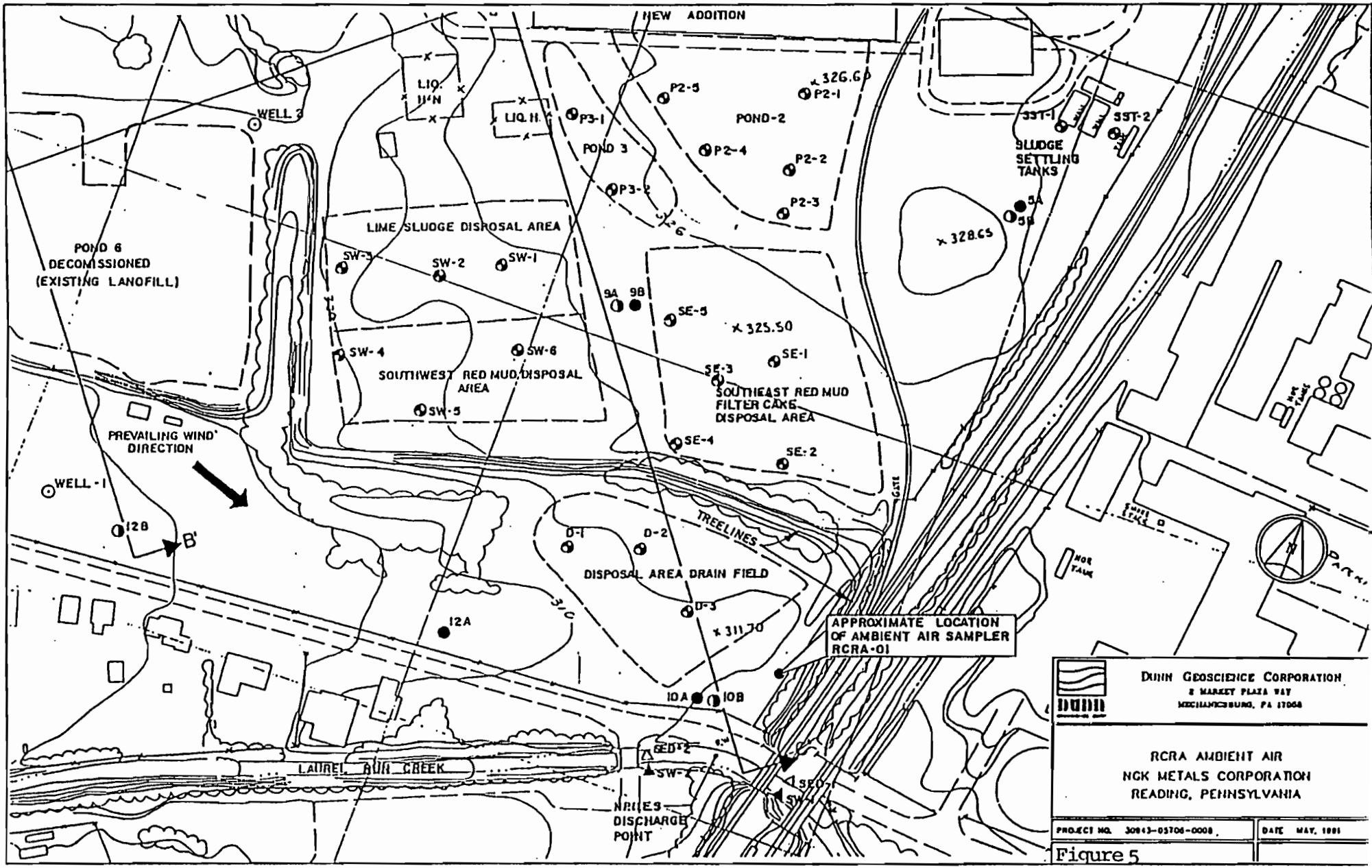
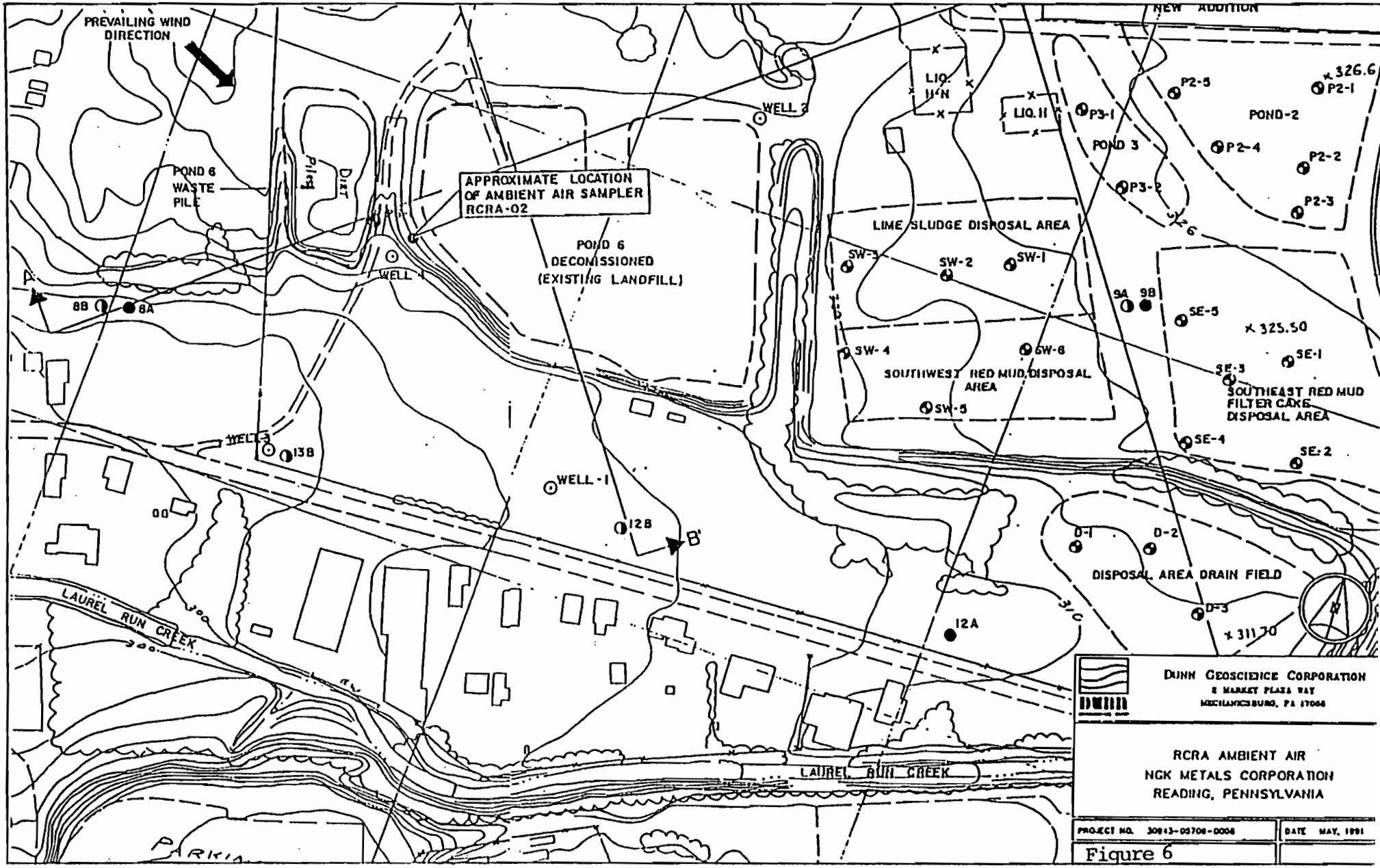


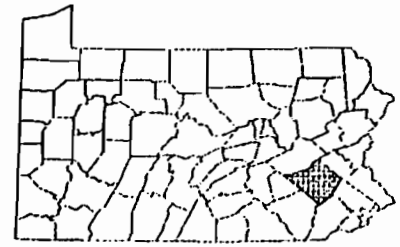
Figure 4
On-site Well Location Map


NEW ADDITION
WELL 3
LIQ. II N
LIQ. II S
POND 3
POND-2
P2-5
P2-1
P3-1
P2-4
P2-2
P3-2
P2-3
326.60
328.65
SST-1
SST-2
SLUDGE SETTLING TANKS
5A
5B
LIME SLUDGE DISPOSAL AREA
POND 6 DECOMISSIONED (EXISTING LANDFILL)
SW-3
SW-2
SW-1
9A
9B
SE-5
325.50
SE-1
SW-4
SW-6
SOUTHWEST RED MUD DISPOSAL AREA
SE-3
SOUTHEAST RED MUD FILTER CAKE DISPOSAL AREA
SW-5
PREVAILING WIND DIRECTION
SE-4
SE-2
WELL-1
12B
B'
TREELINES
D-1
D-2
DISPOSAL AREA DRAIN FIELD
D-3
311.70
12A
APPROXIMATE LOCATION OF AMBIENT AIR SAMPLER RCRA-01
10A
10B
LAUREL RUN CREEK
SED-2
SW-2
SED-1
SW-1
NPDES DISCHARGE POINT
DUNN GEOSCIENCE CORPORATION
2 MARKET PLAZA WAY
MECHANICSBURG, PA 17055
RCRA AMBIENT AIR
NGK METALS CORPORATION
READING, PENNSYLVANIA
PROJECT NO. 30843-03706-0008
DATE MAY, 1991
Figure 5


PREVAILING WIND DIRECTION
POND 6 WASTE PILE
Piles
DIRT
APPROXIMATE LOCATION OF AMBIENT AIR SAMPLER RCRA-02
POND 6 DECOMISSIONED (EXISTING LANDFILL)
WELL 1
WELL 2
WELL 3
WELL-1
8B
8A
13B
12B
12A
00
A
A'
B'
LIQ. II N
LIQ. II
P3-1
P3-2
POND 3
POND-2
P2-5
P2-1
P2-4
P2-2
P2-3
326.6
LIME SLUDGE DISPOSAL AREA
SW-3
SW-2
SW-1
SW-4
SW-6
SW-5
SOUTHWEST RED MUD DISPOSAL AREA
9A
9B
SE-5
325.50
SE-1
SE-3
SOUTHEAST RED MUD FILTER CAKE DISPOSAL AREA
SE-4
SE-2
D-1
D-2
D-3
DISPOSAL AREA DRAIN FIELD
311.70
LAUREL RUN CREEK
LAUREL RUN CREEK
PARKIA
NEW ADDITION
DUNN GEOSCIENCE CORPORATION
RCRA AMBIENT AIR
NGK METALS CORPORATION
READING, PENNSYLVANIA
PROJECT NO. 30913-03708-0008
DATE MAY, 1991
Figure 6

NGK Metals, Corp
Berks County, PA

Sample Locations



Site	Sample#	Date
Res #1	6	10/26/94
Res #2	6	10/25/94
Res #3	6	10/26/94
Res #4	7	10/25/94
Res #5	6	10/26/94
Res #6	7	10/26/94
Res #7	1	11/18/92
UG-1	3	07/27/94
PA-1	3	07/27/94
PA-2	3	07/27/94
PA-3	3	07/27/94

Prevailing Wind Direction

One Mile Buffer

Two Mile Buffer

Figure 7

ATSDR GIS Spatial Analysis Activity

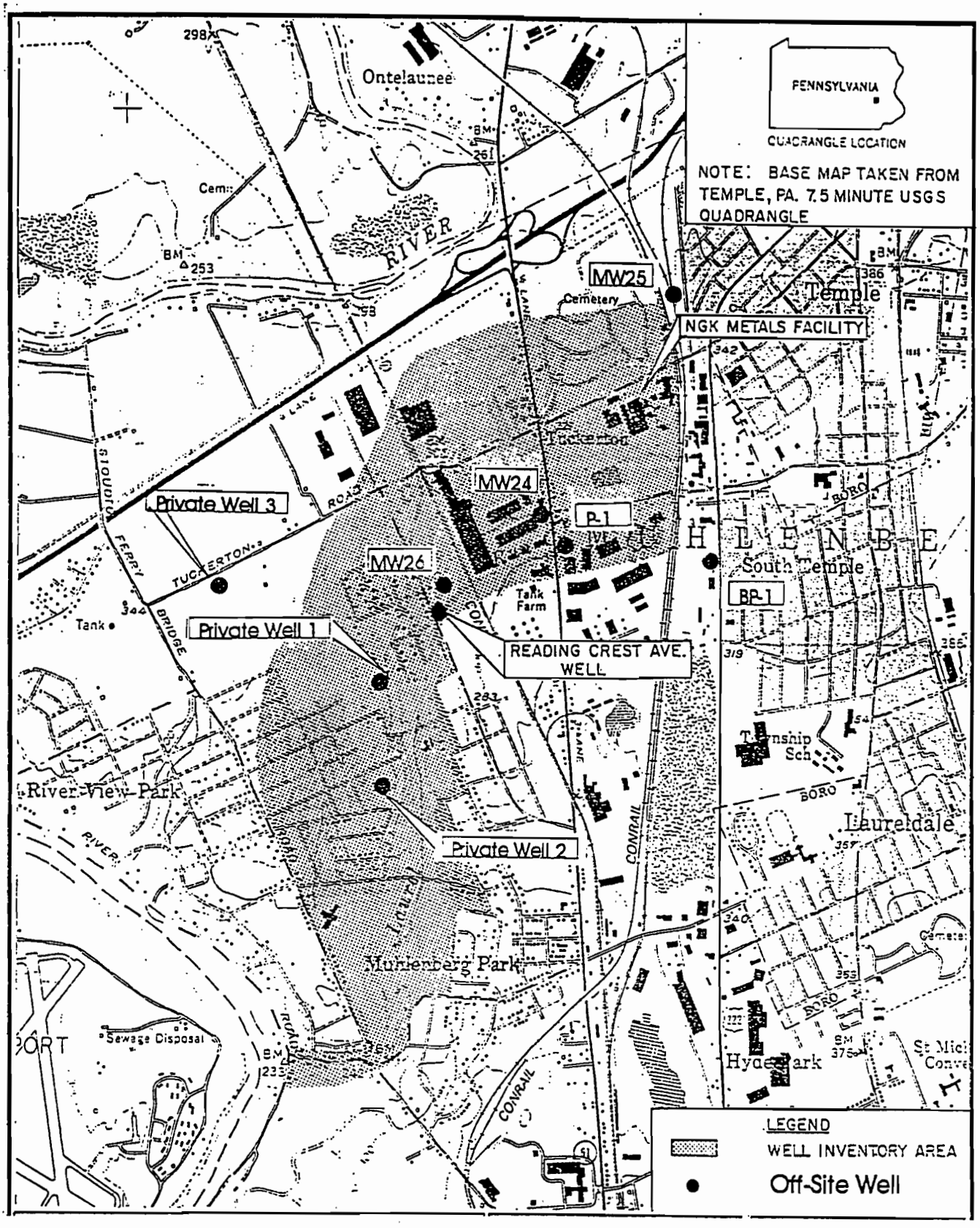


Figure 8
Off-site Well Location Map

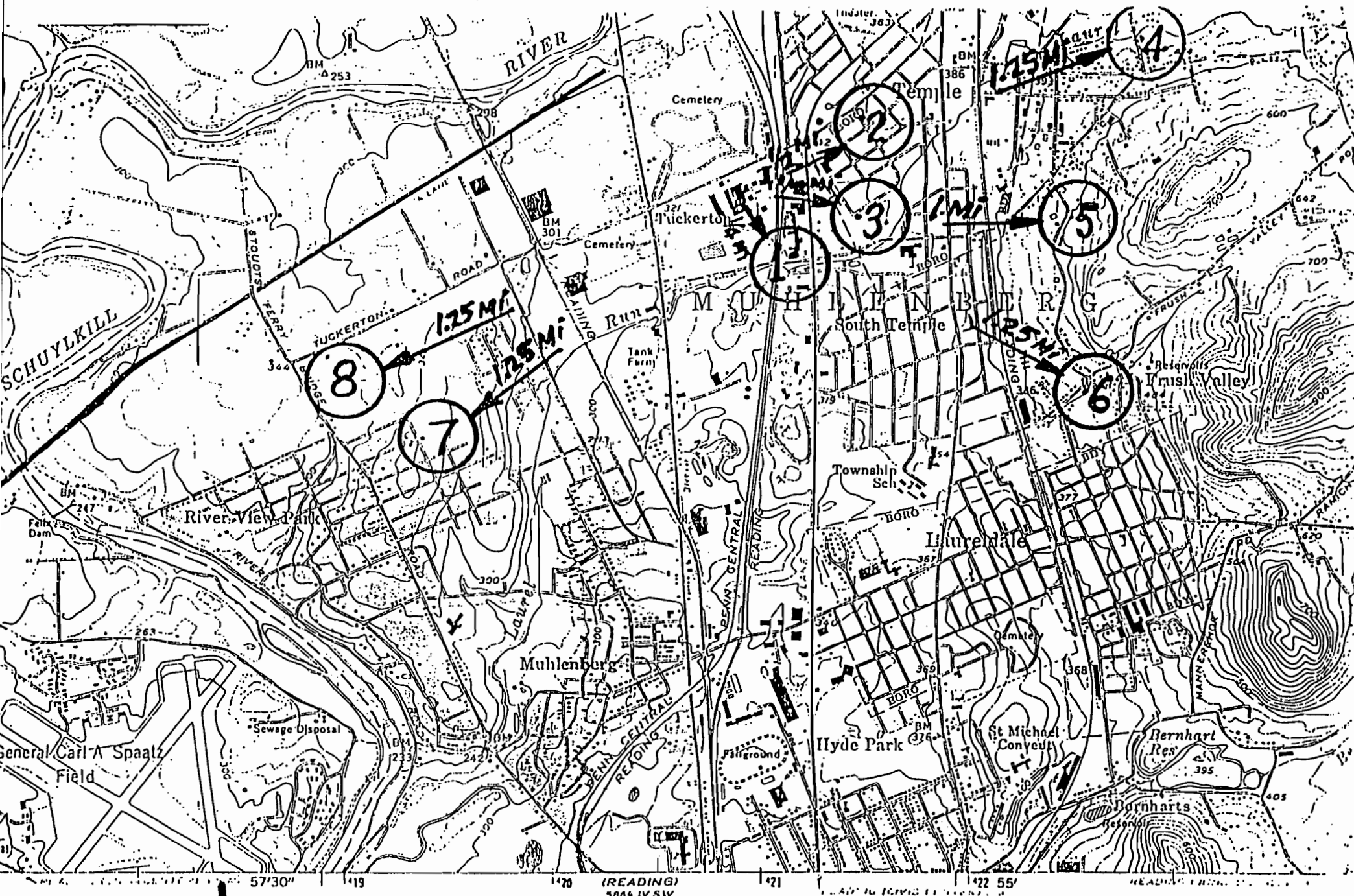
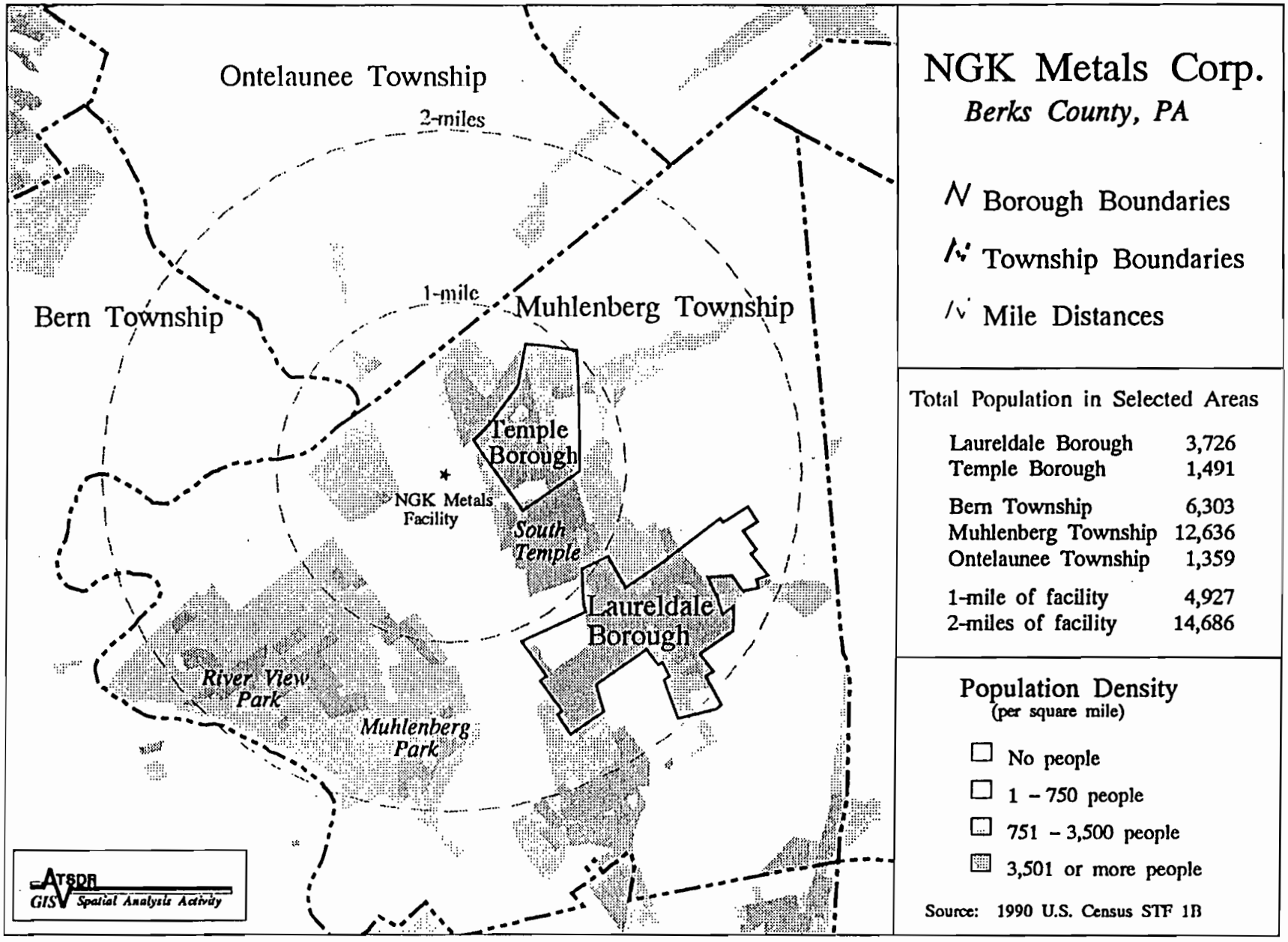


Figure 9
Air Monitoring Stations R1-R8

Figure 10


Ontelaunee Township
2-miles
1-mile
Bern Township
Muhlenberg Township
Temple Borough
NGK Metals Facility
South Temple
Laureldale Borough
River View Park
Muhlenberg Park
ATSDR GIS Spatial Analysis Activity
NGK Metals Corp.
Berks County, PA
Borough Boundaries
Township Boundaries
Mile Distances
Total Population in Selected Areas
Laureldale Borough 3,726
Temple Borough 1,491
Bern Township 6,303
Muhlenberg Township 12,636
Ontelaunee Township 1,359
1-mile of facility 4,927
2-miles of facility 14,686
Population Density
(per square mile)
No people
1 - 750 people
751 - 3,500 people
3,501 or more people
Source: 1990 U.S. Census STF 1B

APPENDIX B

Table 1. Summary Demographic Information for Selected Areas Near the NGK Metals Facility Site, Berks County, PA

	Within 1-mile of the facility	Within 2-miles of the facility	Berks County
Persons	4,927	14,686	336,523
Race			
White	4,849 (98%)	14,441 (98%)	314,561 (93%)
Other	78 (2%)	245 (2%)	21,962 (7%)
Age			
1 to 6 years of age	309 (6%)	956 (7%)	31,602 (9%)
7 to 14 years of age	366 (7%)	1,170 (8%)	34,312 (10%)
15 to 44 years of age	1,832 (37%)	5,427 (37%)	149,968 (45%)
45 to 64 years of age	1,269 (26%)	3,931 (27%)	68,115 (20%)
65 years of age and older	1,151 (23%)	3,202 (22%)	52,526 (16%)
Females 15 to 44 years of age	910 (18%)	2,693 (18%)	75,136 (22%)
Total Housing Units	2,174	6,090	134,482
Occupied Housing Units	2,126 (98%)	5,968 (98%)	127,649 (95%)
Owner Occupied	1,719 (81%)	5,097 (85%)	94,336 (74%)
Renter Occupied	407 (19%)	871 (15%)	33,313 (26%)
Median Housing Value	$72,488	$79,565	$81,800
Square Mile Area	3.13	12.50	859.22
Population Density	1,576/sq. mile	1,175/sq. mile	391.7/sq. mile

Source: U.S. Bureau of the Census. 1991. Census of Population and Housing, 1990: Summary Tape File 1B (Pennsylvania) [machine-readable data files]/ prepared by the Bureau of the Census. Washington: The Bureau [producer and distributor].

Table 2. Summary of the Maximum Concentration of Contaminants Found in On-site Subsurface Soil

Contaminant	Maximum Concentration mg/kg	Date	Comparison Value	
			mg/kg	Source
Antimony	36.9	1989	300	RMEG
Arsenic	179	1989	0.4	CREG
Barium	185	1989	50000	RMEG
Beryllium	10900	1989	0.2	CREG
Cadmium	639	1989	100	EMEG
Chromium (total)	14700*	1989	4000	RMEG
Chromium (VI)	NA		4000	RMEG
Copper	191000E*	1989	38000	EPAIII
Lead	932N	1989	NONE	
Manganese	1220	1989	4000	RMEG
Nickel	290	1989	20000	EPAIII
Selenium	47.7N	1989	2000	EMEG
Thallium	2B	1989	60	RMEG
Vanadium	74.5	1989	7200	EPAIII
Fluoride	10700	1989	40000	RMEG
Nitrate	71.9	1989	1000000	RMEG
1,1-Dichloroethene	NA		1	CREG
Tetrachloroethene	NA		10	CREG
Trichloroethene	NA		60	CREG
1,1,1-Trichloroethane	NA		92000	EPAIII
Vinyl chloride	NA		10	EMEG

Reference: 1

Note: shading shows contaminants of concern for on-site subsurface soil

E reported value is estimated because of the presence of interference

N spiked sample recovery not within control limits

***** duplicate analysis not within control limit

NA not analyzed

Table 3. Summary of the Maximum Concentration of Contaminants Analyzed in On-site Groundwater

Contaminant	Shallow Well µg/L	Date	Deep Well µg/L	Date	Comparison Value	
					µg/L	Source
Antimony	36.8B	12/89	23.5B	12/89	3	LTHA
Arsenic	7.2B	5/90	13	12/89	0.02	CREG
Barium	755	12/89	1010	12/89	700	RMEG
Beryllium	661	6/91	551	5/90	0.008	CREG
Cadmium	53.4	5/90	ND		5	RMEG
Chromium (total)	2550	12/89	1420	12/89	50	RMEG
Chromium (VI)	630	12/89	1360	5/90	50	RMEG
Copper	891	5/90	194	12/89	1300	MCL
Lead	66.4	12/89	66.3	12/89	15	MCLA
Manganese	9270	12/89	12500	12/89	50	RMEG
Nickel	337	12/89	314	12/89	100	LTHA
Selenium	50.3	5/90	6.3BS	12/89	20	IEMEG
Thallium	ND		2.8	12/89	0.4	LTHA
Vanadium	149	12/89	241	12/89	20	LTHA
Fluoride	85000	12/89	160000	5/90	600	RMEG
Nitrate	524000	5/90	37000	12/89	10000	MCL
1,1-Dichloroethene	33	5/90	8	12/89	0.06	CREG
Tetrachloroethene	5	5/90	4J	5/90	0.7	CREG
Trichloroethene	13	12/89	5	5/90	3	CREG
1,1,1-Trichloroethane	410	6/91	33	6/91	200	LTHA
Vinyl chloride	46	5/90	31	5/90	0.2	EMEG

References: 1 (for samples dated 12/89 & 5/90), 7 (for samples dated 6/91)

Note: shading shows contaminants of concern for on-site groundwater

B indicates value below laboratory reporting limit but above instrument detection limit

J indicates estimated value below laboratory reporting limit but above instrument detection limit

S indicates value was determined by the method of standard additions

ND not detected

Table 4a. Summary of the Maximum Concentration of Contaminants Analyzed in Off-site Groundwater

Contaminant	Private Well 1		Private Well 2		Comparison Value	
	µg/L	Date	µg/L	Date	µg/L	Source
Antimony	NA		NA		3	LTHA
Arsenic	NA		NA		0.02	CREG
Barium	NA		NA		700	RMEG
Beryllium	5.3	6/91	<2	7/94	0.008	CREG
Cadmium	<5	12/90	<5	5/91	5	RMEG
Chromium (total)	242	6/91	52.7	6/91	50	RMEG
Chromium (VI)	281J	6/91	43.9	6/91	50	RMEG
Copper	8.6B	6/91	35	7/94	1300	MCL
Lead	<50	12/90	<50	5/91	15	MCLA
Manganese	NA		NA		50	RMEG
Nickel	<40	12/90	<40	12/90	100	LTHA
Selenium	NA		NA		20	IEMEG
Thallium	NA		NA		0.4	LTHA
Vanadium	NA		NA		20	LTHA
Fluoride	1700	12/90	350	6/91	600	RMEG
Nitrate	8670	6/91	5720	6/91	10000	MCL
1,1-Dichloroethene	2	12/90	<1	7/94	0.06	CREG
Tetrachloroethene	10	6/91	<1	7/94	0.7	CREG
Trichloroethene	4J	6/91	<1	7/94	3	CREG
1,1,1-Trichloroethane	15	6/91	6	6/91	200	LTHA
Vinyl chloride	<1	12/90	<1	7/94	0.2	EMEG

References: 5 (for samples dated 5/91), 6 (for samples dated 6/91), 11 (for samples dated 7/94), and 15 (for samples dated 12/90)

Note: shading shows contaminant concentrations that exceed comparison values

B estimated concentration, detected below contract required limit but above instrument detection limit

J estimated value

< indicates that the contaminant was not detected at the reported value

NA not analyzed

Table 4b. Summary of the Maximum Concentration of Contaminants Analyzed in Off-site Groundwater

Contaminant	Private Well 3		Reading Crest Well		Comparison Value	
	µg/L	Date	µg/L	Date	µg/L	Source
Antimony	NA		<1	8/90	3	LTHA
Arsenic	NA		1	8/90	0.02	CREG
Barium	NA		47	8/90	700	RMEG
Beryllium	<5	12/90	11	8/90	0.008	CREG
Cadmium	<5	12/90	6	8/90	5	RMEG
Chromium (total)	<50	12/90	139	10/83	50	RMEG
Chromium (VI)	<20	12/90	130	10/83	50	RMEG
Copper	40	12/90	72	8/90	1300	MCL
Lead	<50	12/90	<20	8/90	15	MCLA
Manganese	NA		29	8/90	50	RMEG
Nickel	<40	12/90	27	8/90	100	LTHA
Selenium	NA		463	8/90	20	IEMEG
Thallium	NA		<1	8/90	0.4	LTHA
Vanadium	NA		<1	8/90	20	LTHA
Fluoride	300	12/90	1700	8/90	600	RMEG
Nitrate	NA		6050	8/90	10000	MCL
1,1-Dichloroethene	<1	12/90	8.1	8/90	0.06	CREG
Tetrachloroethene	<1	12/90	0.9	8/90	0.7	CREG
Trichloroethene	<1	12/90	1.9	8/90	3	CREG
1,1,1-Trichloroethane	<1	12/90	25.7	8/90	200	LTHA
Vinyl chloride	<1	12/90	<0.5	8/90	0.2	EMEG

References: 1 and 16 (for samples dated 8/90), 11 (for samples dated 12/90), 13 (for samples dated 10/83)
Note: shading shows contaminant concentrations that exceed comparison values
< indicates that the contaminant was not detected at the reported value
NA not analyzed

Table 4c. Summary of the Maximum Concentration of Contaminants Analyzed in Off-site Groundwater

Contaminant	P-1 µg/L	BP-1 µg/L	MW24 µg/L	MW25 µg/L	MW26 µg/L	Comparison Value	
						µg/L	Source
Antimony	NA	NA	NA	NA	NA	3	LTHA
Arsenic	NA	NA	NA	NA	NA	0.02	CREG
Barium	NA	NA	NA	NA	NA	700	RMEG
Beryllium	63.3	ND	6.3	3.14B	8.4	0.008	CREG
Cadmium	12.3	ND	ND	ND	ND	5	RMEG
Chromium (total)	43.1	ND	18	ND	5.4B	50	RMEG
Chromium (VI)	100	ND	ND	ND	ND	50	RMEG
Copper	478	104	58.9	ND	13.7B	1300	MCL
Lead	NA	NA	NA	NA	NA	15	MCLA
Manganese	NA	NA	NA	NA	NA	50	RMEG
Nickel	NA	NA	NA	NA	NA	100	LTHA
Selenium	NA	NA	NA	NA	NA	20	IEMEG
Thallium	NA	NA	NA	NA	NA	0.4	LTHA
Vanadium	NA	NA	NA	NA	NA	20	LTHA
Fluoride	930	240	120	<100	350	600	RMEG
Nitrate	692	2800	1010	8520	1140	10000	MCL
1,1-Dichloroethene	ND	ND	ND	ND	ND	0.06	CREG
Tetrachloroethene	ND	ND	ND	ND	ND	0.7	CREG
Trichloroethene	ND	ND	ND	ND	ND	3	CREG
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	200	LTHA
Vinyl chloride	NA	NA	NA	NA	NA	0.2	EMEG

Reference: 6
Dates: P-1, BP-1, and MW24 were sampled 6/91; MW25 and MW26 were sampled 8/91
Note: shading shows contaminant concentrations that exceed comparison values
B detected below contract required limit but above instrument detection limit
NA not analyzed
ND not detected (detection limit not reported)
P-1 = Piezometer **BP-1** = Berks Products Well MW = Monitoring Well

Table 5. Summary of Contaminants detected in Off-site Surface Soil Samples

LOCATION ID	COMPARISON VALUES FOR CONTAMINANTS (mg/kg)					NUMBER OF SAMPLES	DATE
	0.2 CREG	0.2 CREG	10 pRMEG	10 pRMEG	100 pEMEG		
	CONCENTRATION RANGE (mg/kg)						
	Be (TOTAL)	Be (SOLUBLE)	Cr (TOTAL)	Cr^{+6}	Fl		
Residence #1	1.3-2.8	NA	23.4-63.5	NA	NA	6	10/26/94
Residence #2	<0.5-4.9	NA	7.2-37.1	NA	NA	6	10/25/94
Residence #3	1.2-1.9	NA	21.0-29.3	NA	NA	6	10/26/94
Residence #4	2.5-4.3	NA	26.3-92.6	NA	NA	7	10/25/94
Residence #5	0.5-1.6	NA	10.2-21.8	NA	NA	6	10/26/94
Residence #6	1.6-2.3	NA	20.7-45.1	NA	NA	7	10/26/94
Residence #7	2.1	NA	15.0	<0.7	10.2	1	11/18/92
UG-1	1.4-2.7	<0.004-0.0054	18.0-22.0	NA	2.0-5.0	3	07/27/94
PA-1	1.8-3.2	<0.004	21.0-31.5	NA	5.0-10.0	3	07/27/94
PA-2	1.6-3.2	<0.004	17.0-20.0	NA	2.0-3.0	3	07/27/94
PA-3	0.8-6.9	<0.004	20.0-23.0	NA	5.0-7.0	3	07/27/94

References: 10 (Residence 7), 11 (UG-1, PA-1, PA-2, PA-3), 12 (Residence 1-6), and 14 (soluble Be)

Be beryllium

Cr chromium

Cr^{+6} hexavalent chromium

Fl Fluoride

NA not analyzed

< indicates that the contaminant was not detected at the reported value

Notes: 1) there is no comparison value for total chromium, the RMEG used in that column is for Cr^{+6} **2)** the "p" preceeding RMEG and EMEG denotes "pica child" comparison values **3)** shading shows concentrations or upper ranges that exceed comparison values (residence #7 was analyzed for Cr^{+6}; therefore, the total does not exceed the Cr^{+6} or Cr^{+3} [pRMEG 2000 mg/kg] comparison values)

Table 6a. CONTAMINANTS IN LAUREL RUN SURFACE WATER UP AND DOWNSTREAM OF NGK NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OUTFALL (DATA BASED ON RCRA FACILITY INVESTIGATION)

Contaminant	US-1 µg/L			DS-1 µg/L			DS-2 µg/L			DS-3 µg/L	Comparison Value µg/L
	12/89	5/90	6/91	12/89	5/90	6/91	12/89	5/90	6/91	6/91	
Barium	24.9	33.7B	NA	26.6	33.2B	NA	25.5B	34.6B	NA	NA	700 RMEG
Beryllium	ND	ND	<0.2	2.7B	ND	<0.2	1.5B	ND	0.37B	0.92B	0.008 CREG
Chromium	NA	NA	<5.3	NA	NA	<5.3	NA	NA	10.2	41.8	50 RMEG
Chromium VI	ND	ND	<10	ND	ND	<10	ND	ND	<10	NA	50 RMEG
Copper	4.7B	17.1B	<2.5	80.8	23.8B	20.8B	41.6	29.9	26.5	3.3B	1300 MCL
Lead	ND	2.1B	NA	ND	1.8B	NA	1.1B	1.4B	NA	NA	15 MCLA
Manganese	4.6B	6.1B	NA	5.2B	6.7B	NA	6.4B	6B	NA	NA	50 RMEG
Nickel	ND	6B	NA	ND	ND	NA	ND	18.2B	NA	NA	100 LTHA
Nitrate	2360	1690	1480	2730	1790	1630	2670	1880	1660	4140	10000 MCL
Fluoride	130	120	120	220	190	210	160	210	220	870	600 RMEG
1,1-dichloroethene	ND	ND	NA	ND	ND	NA	ND	ND	NA	NA	0.06 CREG
Dichloromethane	ND	ND	6	ND	ND	<5	ND	ND	45	<5	5 CREG
PCE	ND	ND	NA	1B	ND	NA	ND	ND	NA	NA	0.7 CREG
Trichloroethene	ND	ND	NA	ND	ND	NA	ND	ND	NA	NA	3 CREG
1,1,1-trichloroethane	ND	ND	NA	ND	ND	NA	ND	ND	NA	NA	200 LTHA
Vinyl Chloride	ND	ND	NA	ND	ND	NA	ND	ND	NA	NA	0.2 EMEG

NA = not analyzed ND = not detected (detection limit not reported) < = not detected at the reported value B = indicates value below laboratory reporting limit but above instrument detection limit PCE = tetrachloroethene US-1 = upstream of NGK DS-1 = adjacent NGK but just downstream of NPDES
DS-2 = approximately 0.1-0.2 miles downstream of NPDES DS-3 = approximately 1.5 miles downstream of NGK
Notes: (1) shading shows *contaminants of concern* for this medium (2) contaminants are summarized in this table if they were selected as *contaminants of concern* in one of the on-site media or if they exceed the comparison value in this medium (3) on-site *contaminants of concern* which are not listed in this table were not analyzed for (4) references: 1 (for 12/89 & 5/90 samples) and 6 (for 6/91 samples)

Table 6b. CONTAMINANTS IN LAUREL RUN SURFACE WATER UP AND DOWNSTREAM OF NGK (DATA BASED ON STREAM SURVEYS)

Contaminant	Stream Survey 5/13/81 µg/L			Stream Survey 1/26/89 µg/L				Comparison Value µg/L
	US1	DS1	DS2	US01	DS01	DS02	DS03	
Arsenic	NA	NA	NA	<4	<4	<4	<4	0.02 CREG
Barium	NA	NA	NA	36	34	54	40	700 RMEG
Beryllium	1000	2500	1000	<1	4	<1	<1	0.008 CREG
Cadmium	1	1	1	<0.2	<0.2	0.6	<0.2	5 RMEG
Chromium	10	10	10	<50	<50	<50	<50	50 RMEG
Chromium VI	NA	NA	NA	<10	<10	<10	<26	50 RMEG
Copper	10	100	20	<10	102	28	33	1300 MCL
Lead	10	10	10	5.6	15.8	36	<4	15 MCLA
Manganese	340000	210000	450000	11	22	46	<10	50 RMEG
Nickel	NA	NA	NA	<25	<25	<25	<25	100 LTHA
Selenium	NA	NA	NA	<6	6	<6	<6	20 IEMEG
Nitrate	780	1980	2840	NA	NA	NA	NA	10000 MCL
Fluoride	190	360	460	NA	NA	NA	NA	600 RMEG

References: 18 (for 5/13/81 Stream Survey) and 19 (for 1/26/89 Stream Survey)

NA = not analyzed < = not detected at the reported value

US1 = approximately 0.25 miles upstream of NGK **DS1** = approximately 0.2 miles downstream of NGK

DS2 = approximately 2 miles downstream of NGK

US01 = approximately 0.25 miles upstream of NGK

DS01 = approximately 1.5 miles downstream of NGK, but above confluence with unnamed tributary

DS02 = approximately 1.5 miles downstream of NGK, but below confluence with unnamed tributary

DS03 = approximately 2 miles downstream of NGK **Notes:** (1) shading shows *contaminants of concern* for this medium (2) contaminants are summarized in this table if they were selected as *contaminants of concern* in one of the on-site media or if they exceed the comparison value in this medium (3) on-site *contaminants of concern* which are not listed in this table were not analyzed

Table 6c. CONTAMINANTS IN LAUREL RUN SURFACE WATER UP AND DOWNSTREAM OF NGK (DATA BASED ON STREAM SURVEYS)

Contaminant	Stream Survey 1/13/89 µg/L		Stream Survey 10/15/90 µg/L					Comparison Value µg/L
	US	DS	US001	US002	US003	DS001	DS002	
Arsenic	<4	<4	NA	NA	NA	NA	NA	0.02 CREG
Barium	<500	<500	NA	NA	NA	NA	NA	700 RMEG
Beryllium	<1	1	1	1	<25	<25	<25	0.008 CREG
Cadmium	<0.2	<0.2	NA	NA	NA	NA	NA	5 RMEG
Chromium	<4	6.1	NA	NA	<4	<4	<4	50 RMEG
Chromium VI	NA	NA	<10	<10	<10	<10	<10	50 RMEG
Copper	<10	46	15	12	<50	66	<50	1300 MCL
Lead	<4	<4	NA	NA	NA	NA	NA	15 MCLA
Manganese	<50	<50	NA	NA	NA	NA	NA	50 RMEG
Nickel	NA	NA	<25	<25	NA	NA	NA	100 LTHA
Nitrate	2180	2900	3150	3140	960	1500	1480	10000 MCL
Fluoride	140	200	NA	NA	NA	NA	NA	600 RMEG

References: 21 (for 1/13/89 Stream Survey) and 48 (for 10/15/90 Stream Survey)
NA = not analyzed < = not detected at the reported value
US = approximately 50 meters upstream of NGK NPDES outfall
DS = approximately 120 meters downstream of NGK NPDES outfall
US001 = approximately 3 miles upstream of NGK
US002 = approximately 2 miles upstream of NGK
US003 = approximately 0.1 mile upstream of NGK
DS001 = approximately 30 meters downstream of NGK NPDES outfall
DS002 = approximately 1 mile downstream of NGK **Notes:** (1) shading shows *contaminants of concern* for this medium (2) contaminants are summarized in this table if they were selected as *contaminants of concern* in one of the on-site media or if they exceed the comparison value in this medium (3) on-site *contaminants of concern* which are not listed in this table were not analyzed

Table 7. CONTAMINANTS IN WASTEWATER AT THE NGK NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OUTFALL

Contaminant	Individual Sampling of Wastewater Discharge µg/L					DMR Highest Daily Concentration 12/89-10/92	
	1/13/89	3/26/91	3/27/91	9/17/91	10/1/91	Conc. µg/L	Date
Arsenic	<4	NA	NA	NA	NA	NA	
Barium	<500	NA	NA	NA	NA	NA	
Beryllium	18	21.4	11.3	10	13	80	7/90
Cadmium	0.3	NA	0.32	<10	<10	NA	
Chromium	5.1	NA	<4	<50	<50	<10	
Chromium VI	NA	NA	<1	NA	NA	2	12/91
Copper	650	520	305	190	288	2060	8/92
Lead	12.7	129	<4	<50	<50	200	6/91
Manganese	<50	NA	NA	NA	NA	NA	
Nickel	NA	84	<25	<25	<25	47	9/91
Nitrate	4360	NA	NA	NA	NA	NA	
Fluoride	1000	NA	1090	NA	NA	NA	

References: 20 (for 3/26 & 3/27/91 samples), 21 (for 1/13/89 sample), 22 (for 9/17 & 10/1/91 samples), and 23 (for 11/89-10/92 sampling)

NA = not analyzed **<** = not detected at the reported value **DMR** = Discharge Monitoring Report

Note: DMR values for beryllium, copper, and lead reported here exceed permit requirements (daily discharge) for those time periods reported, but compliance with permit requirements were generally met during the 3 years evaluated.

Table 8. CONTAMINANTS IN LAUREL RUN SEDIMENT UP AND DOWNSTREAM OF NGK NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OUTFALL (DATA BASED ON RCRA FACILITY INVESTIGATION)

Contaminant	US-1 mg/kg			DS-1 mg/kg			DS-2 mg/kg			Comparison Value mg/kg
	12/89	5/90	6/91	12/89	5/90	6/91	12/89	5/90	6/91	
Arsenic	0.35B	1B	NA	2.1B	0.89B	NA	1.6B	1.5B	NA	0.4 CREG
Barium	12.2B	22.7B	NA	26B	18.4B	NA	27.2B	28.8B	NA	50000 RMEG
Beryllium	0.36B	0.32B	0.24B	1.2	1.7	2.4	1.3	1.3	1.4	0.2 CREG
Chromium	4.6	9.1	1.1B	7	8.1	14.9	7.4	6.9	5.7	4000 RMEG
Chromium VI	NA	NA	<0.013	NA	NA	<0.011	NA	NA	<0.04	4000 RMEG
Copper	2.9B	7.7	3.7	37.3	58.1	163	23.5	32.7	15.9	38000 EPAIII
Lead	45.7	19	NA	21.8	14	NA	14.5	41.3	NA	NONE
Manganese	72.1	142	NA	127	205	NA	120	256	NA	4000 RMEG
Nickel	3.5B	2.5B	NA	3.5B	2.9B	NA	3.8B	3.5B	NA	20000 EPAIII
Selenium	ND	ND	NA	1.5B	ND	NA	ND	ND	NA	2000 EMEG
Vanadium	6.9B	7.1B	NA	8.6B	61.3B	NA	10.9	8.9B	NA	7200 EPAIII
Nitrate	3.24	1.92	<0.972	2.93	2.33	10.2	3.89	6.66	<1.001	1000000 RMEG
Fluoride	6.79	1.05	<0.1	18.6	75.3	<0.1	36.4	1.11	<0.1	40000 RMEG

References: 1 (for 12/89 & 5/90 samples) and 6 (for 6/91 samples)

NA = not analyzed **ND** = not detected (detection limit not reported) < = not detected at the reported value

B = indicates value below laboratory reporting limit but above instrument detection limit

US-1 = upstream of NGK **DS-1** = adjacent NGK but just downstream of NPDES

DS-2 = approximately 0.1-0.2 miles downstream of NPDES

Note: (1) shading shows *contaminants of concern* for this medium (2) contaminants are summarized in this table if they were selected as *contaminants of concern* in one of the on-site media or if they exceed the comparison value in this medium (3) on-site *contaminants of concern* which are not listed in this table were not analyzed

TABLE 9. CONTAMINANTS IN OFF-SITE AIR

YEAR	AMBIENT AIR MAXIMUM WEEKLY CONCENTRATIONS FOR YEARS 1979-91 BERYLLIUM (μg/m³) STATIONS								Comparison Value (CREG) μg/m³
	R1	R2	R3	R4	R5	R6	R7	R8	
1979	0.00680	0.00060	0.00090	0.00960	0.00130	0.00200	0.00200	0.00220	0.0004
1980	0.00631	0.00041[1]	0.01018[1]	0.00093[4]	0.00260[4]	0.00719[1]	0.00088[1]	0.00088	0.0004
1981	0.04279[5]	0.00027[1]	0.00161	0.00031	0.00024[1]	0.00018[1]	0.00020[1]	0.00018[1]	0.0004
1982	0.00141[3]	0.00307	0.00265	0.00031[3]	0.00033[3]	0.00033[3]	0.00033[3]	0.00017[3]	0.0004
1983	0.00700	0.00014[1]	0.00816	0.00009	0.00038	0.00007	0.00027[1]	0.00012[2]	0.0004
1984	0.00176[1]	0.00078	0.00233	0.00026	0.00099	0.00055	0.00015[1]	0.00010	0.0004
1985	0.00114[1]	0.00860[1]	0.00186	0.00112	0.00180[1]	0.00104	0.00110	0.00159[1]	0.0004
1986	0.01286	0.00079[3]	0.00470[6]	0.00073[3]	0.00210[6]	0.00078[3]	0.00158	0.00500[1]	0.0004
1987	0.02910	0.00129	0.00190[2]	0.00110	0.00225	0.00093	0.02130	0.00119	0.0004
1988	0.00314	0.00029[1]	0.00197	0.00171[5]	0.00046	0.00039	0.00013[1]	0.00030	0.0004
1989	0.08143	0.02105	0.02046	0.00204	0.00178	0.00122	0.00248[3]	0.00181	0.0004
1990	0.00205	0.00045	0.00078	0.00018	0.00020	0.00031	0.00034	0.00020	0.0004
1991	0.00109	0.00068	0.00162[7]	0.00025	0.00043	0.00056	0.00040	0.00031	0.0004
1992	0.00105	0.00027	0.00076	0.00017	0.00019	0.00018	0.00017	0.00028[7]	0.0004
1993	0.00099	0.00039[7]	0.00062	0.00035[7]	0.00023	0.00020	0.00033	0.00028	0.0004
1994	0.00059	0.00094	0.00119	0.00060	0.00069	0.00094	0.00070	0.00055	0.0004

Reference: 25 Locations of air monitors are in Figure 9 Note: Shading shows concentrations that exceed the comparison value
Weekly concentrations are based on 7-day samples unless noted as follows: [1] 1 day concentration [2] 2 day concentration [3] 3 day concentration
[4] 4 day concentration [5] 6 day concentration [6] 8 day concentration [7] < 7 days were sampled; but actual number of days not reported
Sampling began on 8/1/79 and is reported through the end of 1994

TABLE 10. CONTAMINANTS DETECTED IN AIR AT ON-SITE AND OFF-SITE LOCATIONS

STATION	ON-SITE/OFF-SITE SITE AIR DATA					
	DATE	$\mu g/m^3$				SOURCE
		BERYLLIUM	COMPARISON VALUE	CHROMIUM, TOTAL	COMPARISON VALUE	
RCRA 01	7/2/91	0.00062	0.0004	0.00448	0.00008	8
RCRA 02	7/2/91	0.00042	0.0004	0.00472	0.00008	8
R-1	7/2/91	0.00015	0.0004	0.0063	0.00008	8
RCRA 01	7/9/91	0.00011	0.0004	0.00159	0.00008	8
RCRA 02	7/9/91	0.00023	0.0004	0.00145	0.00008	8
R-1	7/9/91	0.00007	0.0004	0.00199	0.00008	8
RCRA 01	7/16/91	0.00079	0.0004	0.00344	0.00008	8
RCRA 02	7/16/91	0.00034	0.0004	0.00284	0.00008	8
R-1	7/16/91	0.00039	0.0004	0.00399	0.00008	8
RCRA 01	7/23/91	0.00019	0.0004	0.00616	0.00008	8
RCRA 02	7/23/91	0.00017	0.0004	0.00450	0.00008	8
R-1	7/23/91	0.00011	0.0004	0.00827	0.00008	8
RCRA 01	7/30/91	0.00027	0.0004	0.00269	0.00008	8
RCRA 02	7/30/91	0.00038	0.0004	0.00274	0.00008	8
R-1	7/30/91	0.00018	0.0004	0.00512	0.00008	8

Note: Shading shows values that exceed the CREG comparison values
RCRA 01 = On site **RCRA 02** = On site **R-1** = off site

Table 11. COMPLETED EXPOSURE PATHWAYS

PATHWAY NAME	SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	TIME
Off-site Groundwater	NGK	Groundwater	Private Well 1 and 2	Dermal Contact Ingestion Inhalation[1]	Users of Private Wells 1 and 2	Past Present[2] Future[2]
On-site Ambient Air	NGK	Ambient Air	On-site and Off-site Around NGK	Inhalation	On-site Workers	Past Present Future
Off-site Ambient Air	NGK	Ambient Air	Off-site Around NGK	Inhalation	Residents and People Working Near NGK	Past Present Future
Off-site Soil	Unknown	Soil	Public and Private Areas	Dermal Contact Ingestion	Residents and People Working and Recreating Near NGK	Past Present Future

[1] Applies to Private Well 1 only
[2] Applies to Private Well 2 only

Table 12. Potential Exposure Pathways

PATHWAY NAME	SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	TIME
On-site Soil	NGK	Soil	On-site Waste Areas	Dermal Contact Ingestion Inhalation	On-site Workers and Nearby Residents	Past Present Future
Off-site Groundwater	NGK	Groundwater	Private Well 3 and Use of Wells from within the Contaminant Plume	Dermal Contact Ingestion Inhalation	Users of Private Well 3 and Groundwater within the Contaminant Plume	Past Present Future
Off-site Sediment	Point and Non-point Discharge Sources Along Laurel Run	Sediment	Laurel Run	Dermal Contact Ingestion	Users of Laurel Run	Past Present Future
Off-site Surface Water	Point and Non-point Discharge Sources Along Laurel Run	Surface Water	Laurel Run	Dermal Contact Ingestion	Users of Laurel Run	Past Present Future
Off-site Biota	NGK and Other Air and Surface Water Pollution Sources	Fish, Fruits, and Vegetables	Laurel Run and areas around NGK and Laurel Run	Ingestion	Laurel Run Fisheaters and Consumers of Locally Grown Fruits and Vegetables	Past Present Future
Workers' Clothing	NGK	Workers' Clothing	Residences	Dermal Contact Ingestion Inhalation	Family Members of Workers Who Were Exposed to Contaminants	Past

APPENDIX C

Comparison Values

Comparison values for ATSDR public health assessments are media-specific concentrations used to select contaminants for further evaluation. Comparison values are not thresholds of toxicity; therefore, it does not necessarily follow that adverse health effects will occur when environmental concentrations exceed comparison values. These values are used in the preliminary identification of *contaminants of concern* at a site. The probability of adverse health outcomes will depend on site-specific conditions that affect the route and duration of actual exposure, and not on environmental concentrations alone. Comparison values used in the Environmental Contamination and Other Hazards and the Public Health Implications sections of this petitioned public health assessment are listed and described.

CREG = Cancer Risk Evaluation Guides
EMEG = Environmental Media Evaluation Guides
EPAIII = EPA Region III
IEMEG = Intermediate Environmental Media Evaluation Guides
LTHA = Drinking Water Lifetime Health Advisory
MCL = Maximum Contaminant Level
MCLA = Maximum Contaminant Level Action
MRL = Minimal Risk Level
RfD = Reference Dose
RMEG = Reference Dose Media Evaluation Guide
PEL = Permissible Exposure Limit

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations expected to cause no more than one excess cancer in a million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors.

Environmental Media Evaluation Guides (EMEGs) are calculated from ATSDR minimal risk levels; they factor in body weight and ingestion rates.

Environmental Protection Agency Region III (EPAIII) are risk-based concentrations which take into account factors such as body weight, toxicity, and exposure duration and frequency for non-carcinogens and carcinogens, when applicable.

Intermediate Environmental Media Evaluation Guides (IEMEG) are calculated from ATSDR minimal risk levels; they factor in body weight and ingestion rates for intermediate exposures (greater than 14 day and less than 1 year).

Lifetime Health Advisories (LTHAs) are contaminant concentrations that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters of water per day.

Maximum Contaminant Levels (MCLs) represent contaminant concentrations in drinking water that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters of water per day (for an adult).

Maximum Contaminant Level Action (MCLA) are action levels set by EPA under Superfund that trigger a response or action when contaminant concentration exceed this value.

Minimal Risk Levels (MRL) are estimates of daily human exposure to a chemical (in mg/kg/day) likely to occur without an appreciable risk of deleterious effects (noncancer) over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are reported for acute ($\leq$ 14 days), intermediate (15-364 days), and chronic ($\geq$ 365 days) exposures. MRLs are published in ATSDR Toxicological Profiles for specific chemicals.

EPA's Reference Dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause adverse health effects. However, RfDs do not consider cancer effects.

Reference Dose Media Evaluation Guide (RMEG) is a concentration derived from an EPA reference dose with assumed body and ingestion rates factored into the calculation.

The Occupational Safety and Health Administration's Permissible Exposure Limit (PEL) for air is an 8-hour, time-weighted average developed for the workplace. The level of exposure may be exceeded (for brief periods), but the sum of the exposure levels averaged over 8 hours must not exceed the limit.

APPENDIX D

Comments Received During the ATSDR Public Comment Period September 1 - November 12, 1993

Note: The comments in this appendix were received during the public comment period for the NGK Metals Petitioned Public Health Assessment dated September 1, 1993. Therefore, comments refer to text discussions, pages numbers, tables, and figures of that document. Based on the comments, new data and information, and further toxicological research, revisions were made to the public comment release petitioned public health assessment and are reflected in this (final) document. Unless otherwise noted, ATSDR's responses reference page numbers, tables, and figures contained within this document.

Comment 1: In referring to the company as "Cabot" etc., you completely neglect to mention two 1990 indictments of NGK by the Pennsylvania Attorney General for solid waste violations for which NGK pleaded "no contest" and paid heavy fines. You have attributed all dangers to the community to past owners when, in fact, the dangers have continued with the present owners.

Response to comment 1: ATSDR indicates on page 3, the names of former companies, as well as the company presently operating the facility. The Site Description and History subsection (pages 3 and 4) provides a brief overview of the site and its operation. ATSDR public health assessments are developed to assess environmental and health data. Although some enforcement items are highlighted and discussed, public health assessments are not intended to chronicle regulatory and compliance issues. In the Environmental Contamination and Other Hazards section, ATSDR reports past and present contamination and maximum concentration levels, based upon available health data, rather than regulatory compliance. In this assessment, ATSDR has attempted to focus on current environmental data that characterize the current condition of the site and surrounding community, as well as indicate any past levels that may have presented a health hazard.

Comment 2: The site history does not include the role of the Department of Defense (DOD) during the years in the 1940's when they operated the plant. Your report indicates you didn't even ask for records from the DOD concerning field spreading and dumping (page 37, community concern number 22).

Response to comment 2: As stated in the response to comment 1, ATSDR provides a brief overview of the site history and discusses environmental contamination, with particular emphasis on the current site condition. In discussing site history, ATSDR referenced (reference number 1) the "NGK Metals Corporation RCRA Facility Investigation." Although ATSDR does not question or dispute that DOD contracted work or was in some way involved with the facility, the RCRA Facility Investigation (RFI) does not report any DOD involvement or more importantly, it does not report any environmental data during that time period that might be useful to this assessment. Under "Waste Management History," during

the time period in question the RFI states, "Prior to the early 1950's, detailed information describing waste management activities at the Reading plant is scarce. Reportedly, during the early 1940's, a retention basin existed along the eastern edge of the plant property adjacent to the Tuckerton Road. There are no files in the plant records indicating what materials flowed into the pond. The only record of the pond exists on a Beryllium Corporation drawing showing the location and approximate outline of the pond." It is likely that a variety of waste practices and subsequent contamination have taken place at the site during the past 50-60 years; however, there is very little documented record of what has occurred. In an effort to address this concern, ATSDR recommended surface soil sampling at uncovered on-site waste areas, as well as other areas where migration may have occurred. However, due to information provided in Comment 44 and due to pending remediation ATSDR has revised that recommendation. In recommendation number 1, ATSDR is also requesting representative on-site surface soil sampling when remedial activities are complete.

Comment 3: Assessments are made using "assumptions about quality control issues" and "insufficient data."

Response to comment 3: Since ATSDR does not conduct its own environmental sampling we must rely on available data collected by various agencies and organizations. Of the data reviewed by ATSDR, it is assumed that adequate quality assurance and quality control measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. However, questions or problems, regarding data, that are identified are discussed in the Quality Assurance/Quality Control subsection (page 19). ATSDR is sometimes required to make a decision based on limited information and data; however, if data are too limited or are in some way "insufficient," ATSDR will state those facts when evaluating a site.

Comment 4: Valid conclusions cannot be reached in the light of: a) improper air sample tests, b) no off-site biota data, c) only one off-site surface sample, and d) no smoke stack monitoring.

Response to comment 4: It is ATSDR's belief that the conclusions made in this petitioned public health assessment are accurate and valid, based upon the data and information reviewed. ATSDR acknowledges the need for some of the above mentioned items, specifically off-site biota sampling and additional off-site surface soil sampling (arsenic, cadmium, copper, and lead only, based on recent sampling), and therefore no conclusions were made in that regard. ATSDR has evaluated air data as analyzed and reported by NGK, but indicated in the Quality Assurance/Quality Control subsection (page 20) that some questions regarding that data are being investigated by EPA. ATSDR will reassess that data if the results of EPA's investigation warrant reassessment. Since ambient air data is available, ATSDR has not requested stack monitoring. Although ambient air monitoring

alone generally cannot be directly linked to a single source; it commonly provides a better indicator of exposure to the general public than stack monitoring.

Comment 5: In your section on community concerns no mention was made about birth defects as told to you at your public hearing.

Response to comment 5: At the public availability session held on June 8, 1993, ATSDR noted your concern as being more specific than birth defects. You stated that three out of a family with children had diabetes and that two out of three children from another family had congenital heart defects. Those concerns were addressed, along with other specific health concerns, in number 16 on page 39. None of the chemicals of concern identified at the site are known to be associated with birth defects in humans at the concentrations detected off-site.

Comment 6: No mention is made of an available test (blood test) approved by the ATSDR to show if a person has been exposed to beryllium.

Response to comment 6: The beryllium lymphocyte proliferation test is mentioned in the "Public Health Implications" section of the final petitioned public health assessment (page 29 under the beryllium "Inhalation Exposure" subsection). See also the responses to comments 7-9 below.

Comment 7: Item number four [page 32] addresses the concerns that residents living in the Reading area may develop sarcoidosis from exposure to beryllium oxide. In your response you say that beryllium disease may be an immune response and from 1973-77 only one documented nonoccupational case was reported nationwide. Beryllium disease is well known to be an immunologically-mediated disease. The bronchoalveolar lavage cells, is an invitro measure of this beryllium-specific, cellular immune response and had become the principal diagnostic tool in differentiating beryllium disease from sarcoidosis. There has been a non-occupational case of beryllium disease recently reported in the literature by our group. The patient carried a diagnosis of sarcoidosis for many years before diagnosis of beryllium disease was made. Enclosed is a reprint of that case report [see Appendix E]. You state in your response, "the amount of beryllium exposure needed to cause beryllium disease is uncertain." We agree, as we have seen cases of beryllium sensitization and disease in persons with a wide range of exposures, some seemingly quite trivial. Anyone with sarcoidosis who has plausible beryllium exposure, either from living near the plant or having a person in the home who worked in the plant, should be tested for beryllium sensitization to rule out beryllium disease.

Response to comment 7: This issue is addressed in the "Public Health Implications" section of the final petitioned public health assessment (page 29 under "Inhalation Exposure" and revised in number 4, page 35 under "Community Health Concerns Evaluation"). The

symptoms of nonoccupational CBD are very similar to those of sarcoidosis so it is possible that the former disease may readily be misdiagnosed as the latter. However, it is currently possible to distinguish between sarcoidosis and chronic beryllium disease (CBD) using the beryllium lymphocyte transformation (or proliferation) test. This test may be performed on a blood sample, but results are more reliable when performed using bronchiolar/alveolar lavage fluid. Any long-term residents who have been diagnosed as having sarcoidosis and who suspect that they may have been exposed to clinically significant levels of beryllium in the past may want to consider consulting an occupational/environmental medicine specialist to determine whether specialized testing for beryllium sensitivity is appropriate.

Comment 8: Item number 18 [page 36] addresses concerns that dust carried home from the beryllium plant may have resulted in illness. Again, the enclosed case report (see Appendix E) addresses the potential for this type of non-occupational exposure.

Response to comment 8: Current industrial hygiene practices are designed to eliminate such pathways of off-site exposure. However, at this late date, it is not possible to determine who, if anyone, was exposed to beryllium via this pathway decades ago. Any long-term residents who suspect they have been exposed in this way, especially if they have since been diagnosed with sarcoidosis, may want to consider consulting an occupational/environmental medicine specialist to determine whether specialized testing for beryllium sensitivity is appropriate.

Comment 9: Finally, item 30 [page 39] addresses CD4+ T cell levels and beryllium in lung tissue of sarcoidosis cases. We agree with your response that CD4+ T cell levels are not helpful in screening for beryllium disease. However, the beryllium lymphocyte transformation test on peripheral blood can be used as a screening test for residents who may have signs or symptoms of beryllium disease. We have also looked at measurable beryllium in lung tissue of beryllium disease cases. Although many patients have beryllium in lung tissue, we do have some patients who have negative beryllium levels, possibly due to sampling error. However, these patients have positive response to beryllium in blood or bronchoalveolar lavage cells as demonstrated with the lymphocyte transformation test. Thus tissue levels of beryllium are not helpful in diagnosing or excluding beryllium disease. If persons living around the NGK plant have concerns about beryllium disease or question a previous respiratory diagnosis, the beryllium lymphocyte transformation test is available for both screening and diagnostic purposes.

Response to comment 9: This issue is addressed in the "Public Health Implications" section of the final petitioned public health assessment (page 29 under "Inhalation Exposure" and page 42 under "Community Health Concerns Evaluation," number 30). CD4+ T cells may accumulate in the lungs in response to many factors other than beryllium exposure. Such a nonspecific indicator of exposure to beryllium would be of little use in identifying beryllium lung disease. Sarcoidosis presents much the same signs as does beryllium disease, except for

the demonstrable presence of beryllium in the lungs. Thus, in order for a granulomatous lung disease to be diagnosed as beryllium disease, the presence of beryllium in lung tissue must be directly or indirectly demonstrated. Currently, the easiest way to do that is to test for beryllium sensitivity in white cells from blood or bronchoalveolar lavage fluid.

Comment 10: I do not think the Public Health Assessment is complete and accurate. I was unaware of any potential link to sarcoidosis until I read a recent article in the newspaper. I believe all physicians should be surveyed for sarcoidosis patients and then those patients should be checked for possible links to NGK Metals.

Response to comment 10: ATSDR believes that this assessment is both complete and accurate. Completeness, however, is based on ATSDR's evaluation of available data and the acknowledgement of data gaps, where additional data is needed (and is requested) to make further conclusions. ATSDR discusses sarcoidosis on page 29 under "Inhalation Exposure" and page 35, under "Community Health Concerns Evaluation," number 4. ATSDR public health assessments evaluate environmental data, exposure pathways, possible adverse health effects, and health outcome data to determine whether a hazardous waste site may present a health threat. An ATSDR public health assessment is **not** the same thing as a medical exam or a community health study. However, it can sometimes lead to those things, as well as other public health activities.

Comment 11: I have worked and/or lived near NGK Metals since August 1965. I worked at Metropolitan Edison Company, 2800 Pottsville Pike (Route 61), from 1965 to about 1972. I have lived in the Riverview Park area of Muhlenberg Township since 1971. I lived at 1051 Grandell Ave. from September 1985 to the present. I have attended two churches in the area, the most recent one being across the highway (Route 61) from NGK Metals. I have spent considerable time in the NGK Metals area shopping, eating out, attending movies, etc. During preadmission testing for surgery in 1989, my chest x-ray led to additional tests and my doctor informed me that I have sarcoidosis. This aggravated a bronchial asthma condition which surfaced in 1985. Since, as a male, I am not supposed to have sarcoidosis, I thought you should be aware of my situation. I wonder how many others remain unaware of any potential link between NGK Metals and their health.

Response to comment 11: Thank you for your comment and information regarding this illness. However, it should be noted that sarcoidosis is not a disease that is peculiar to women. Among american blacks, it does appear to be more common among women, but recent studies tend to refute this. Among caucasians, the incidence is very similar in both sexes. The incidence and expression of sarcoidosis varies more between ethnic groups and nationality than it does between occupations, which is consistent with the greater importance of genetic factors over exposure variables in this disease. Sarcoidosis is the result of an overzealous immune response to one or more of a variety of provoking agents or tissue insults, and genetic factors may be of primary importance.

Comment 12: After reading the report I have come to the conclusion that the ATSDR has done an outstanding investigative job of proving that the NGK plant in Muhlenberg Township has been discharging highly toxic pollutants in the air and in the groundwater since its inception, but has done such a pitiful and insignificant job in proving that people, human beings, have gotten serious illnesses as a result of it. What value is this report if you site only two residents, found on page thirty-two number four, "Residents living in the Reading area may develop sarcoidosis from exposure to Beryllium Oxide." If I had not supplied this information, your report would not have had any validity. Can you imagine submitting to the public, a health assessment that shows no one getting ill from the effects of Beryllium?

Response to comment 12: The quoted statement - "Residents living in the Reading area may develop sarcoidosis from exposure to Beryllium Oxide" - is listed in the petitioned public health assessment as an identified community health concern (pages 8 and 35), and not as a medical conclusion of ATSDR. In fact, none of the evidence available to ATSDR supports the conclusion that "people, human beings, have gotten serious illnesses as a result of it [i.e., off-site beryllium exposure near NGK]." As discussed in the "Public Health Implications" section of the final petitioned public health assessment, chronic beryllium disease does mimic the symptoms of sarcoidosis, but it should neither be equated with the latter disease nor even viewed as evidence of exposure to beryllium. A clinical test (the beryllium lymphocyte transformation test) is now available that can distinguish between sarcoidosis and beryllium lung disease. As stated in the "Response to comment 10," the evaluation of environmental data, exposure pathways, and possible adverse health effects are a primary part of an ATSDR public health assessment. Evaluating health outcome data is another area of emphasis. This is done primarily through the review of available databases, health studies, and community concerns, such as those reported to us by you and other residents. It should be noted again that a public health assessment is not a medical exam or a community health study, but its health outcome data review does sometimes show trends that may prompt health follow-up, such as a community health study.

Comment 13: This part of your report is thoroughly remiss. I'm appalled and shocked that your investigative team could not come up with any other residents who are suffering from Beryllium related illnesses or who may have died as a result of Beryllium poisoning. Did your team bother to talk to any local Muhlenberg Township barbers? All I had to do was ask my barber. When I asked him the question, "do you know anyone who lives near the NGK plant or works there who may have a breathing problem." Off the top of his head he named six residents who either work there or live near the plant that were ill. Two of them have died. Did any member of the investigative team bother to go to the Berks County Courthouse to research how many residents sued or are presently suing NGK in Civil Court for causing their illness. In my research I filled two papers on both sides with names of local residents. People who settled out of court were not listed in the files. Who knows how many settled out of court? Did your team bother to check with any local Pulmonary Specialist to see how many Muhlenberg Township residents they may be treating or have

treated in the past for acute breathing problems? I had no authority to do that, but during my own investigation of how my wife could have gotten this illness, I had several Muhlenberg Township women call me on what course they should take for fear of having symptoms of sarcoidosis. And none of these women were African-Americans. In fact in my eight years of researching and investigating this illness, out of all the people I came into contact with who were suffering from this disease not one was an African-American female. In fact, out of thousands of pages of research that I acquired through the Freedom Of Information Act, not one gave the statistic of ninety percent of sarcoidosis cases occur in African-American women. I would like you to send me a copy of that study. I just can't believe your information.

Response to comment 13: Please refer to the responses to comments 10 and 12 regarding what a public health assessment is and does. ATSDR staff has not talked with local barbers or local pulmonary specialists, nor has it checked courthouse records. Although some of these actions could prove to be reasonable sources of information, they are not typically used in gathering information for a public health assessment. Sources that were used in developing this public health assessment are enumerated in the References section on page 50. Actions that have been taken by ATSDR in an effort to collect information include: contact and file reviews of federal and state environmental and health agencies, contact with local municipalities, reviewing federal and state health databases, visiting the NGK facility, personal conversations with concerned citizens during the site visit and public availability sessions, initiating telephone calls to concerned citizens, receiving letters and telephone calls from concerned citizens, and issuing the petitioned public health assessment for public comment.

Statistics on the incidence and prevalence of sarcoidosis are highly uncertain due to the relative rarity of this chronic disease, the variable severity of its symptoms, the potential for misdiagnosis, and non-representative nature of most study populations. It is clear, however, that the incidence of sarcoidosis in the U.S. is much higher in blacks than in whites (47). The statement in an earlier draft to the effect that sarcoidosis occurs only in women was in error. That error has been corrected in the final document. There is no sex predominance in the incidence of sarcoidosis worldwide, and, in caucasian populations, cases of sarcoidosis are almost equally divided between men and women. Although the disease has been reported to be 2-3 times as common among black females as black males, this finding may only reflect the fact that most of the early studies were done in large urban hospitals where the majority of patients seeking medical attention for any ailment happened to be females, especially black females. The current consensus is that there is no predominance of sarcoidosis among women in general or black women in particular (47). Of all the potential risk factors studied (i.e., genetic, racial, infectious, environmental, occupational, smoking, and presence of other disease), only genetics and possibly geography are well established risk factors for sarcoidosis.

Comment 14: I would like to point out what I think is a glaring contradiction in your report. On page thirty-two, number four, "Residents living in the Reading area may develop sarcoidosis from exposure to Beryllium Oxide," the report states that Beryllium causes a sarcoidosis like condition. In fact, a letter that I received from a military doctor, a copy which I submitted to the ATSDR, specifically states, "the only known cause of sarcoidosis is beryllium," so I agree with your statement. However, the very next line in the report states, "Sarcoidosis is a chronic disease of unknown cause..." How can you state in one sentence that Beryllium causes sarcoidosis and the next sentence states it is a disease of unknown cause. I'm confused. Either there is a cause or there isn't a cause. It can't be both.

Response to comment 14: On page 32, under community concern number 4 (of the public comment draft petitioned public health assessment), you accurately point out that ATSDR states, "beryllium causes a sarcoidosis-like condition." The sarcoidosis-like condition that ATSDR is referring to is chronic beryllium disease (or Berylliosis). ATSDR does not state that sarcoidosis is caused by beryllium. Sarcoidosis and chronic beryllium disease are separate illnesses with similar symptomology. Because of their similarity, chronic beryllium disease is sometimes misdiagnosed as sarcoidosis (for further reference you can review the article, "Nonoccupational Beryllium Disease Masquerading as Sarcoidosis: Identification By Blood Lymphocyte Proliferative Response to Beryllium," in Appendix E). The cause of sarcoidosis is unknown.

Comment 15: In the second paragraph on page thirty-two, the report again states, "one type of sarcoidosis like disease is caused by Beryllium." The next sentence states that the ATSDR has examined sarcoidosis as a potential site-related health effect. Then the report states the amount of Beryllium exposure needed to cause Beryllium Disease is uncertain. The last sentence in the paragraph states, "Current data did not allow ATSDR to find a relationship between the site and the case."

Response to comment 15: Because the symptoms of sarcoidosis (which has an unknown causative agent or agents) are very similar to those of beryllium disease (which is caused by beryllium exposure) and since cases of sarcoidosis have been reported in the area, ATSDR has examined sarcoidosis as a potential site-related health effect. It is typically quite difficult to make a definitive link between an illness and an environmental exposure even when the causative agent is known. Current data does not allow ATSDR to determine a link between the site and the reported cases of sarcoidosis.

Comment 16: This report is a sham. Whoever wrote it and whoever investigated it wasted their time. The report has dismissed the only two cases as not being applicable to the NGK plant. How can you publish a health assessment concerning a toxic substance but can't prove any residents suffer ill effects from it? Why bother at all? I'm tired of relating my wife's case to prove breathing Beryllium Oxide is extremely hazardous to ones health. She lived a half a mile from the NGK plant on Seventh Avenue in Temple for half of her life. She

breathed the air and played in the dry dirt. At the age of thirty-four she has one-third breathing capacity compared to a normal adult. A biopsy of her lungs shows that she has Beryllium in her lungs. How much Beryllium dust does it take for a person to lose two-thirds of their breathing capacity? According to Dr. Lee Newman, an occupational medicine specialist at the National Jewish Center for Immunology and Respiratory Medicine, a very minute amount of Beryllium can cause the disease. I am shocked and appalled that your team of investigators can make a statement that current data does not allow ATSDR to find a relationship between the site and my wife's illness. In my opinion, the bottom line is this, if your team had done an adequate investigative job, interviewing the right people, the report should have stated that the residents of Muhlenberg Township who live within a radius of five miles from the NGK plant are getting ill and will continue to get ill. They may not get a breathing disorder such as sarcoidosis or Berylliosis. Brain tumors and certain cancers have become prevalent to some residents who live near the plant.

Response to comment 16: ATSDR has not dismissed sarcoidosis as a potential site-related health effect. As stated in the response to comment 15, current data does not allow ATSDR to determine a link between the site and the reported cases of sarcoidosis. ATSDR commonly cannot prove that a toxic chemical in the environment is causing a particular illness. However, if there is sufficient environmental and health data, ATSDR is able to determine whether a toxic chemical is likely to cause an adverse health effect. The available data at this site does not currently allow ATSDR to make that determination. ATSDR is requesting additional data that may enable ATSDR to determine whether adverse health effects are likely to result from current conditions at or around the site. ATSDR appreciates the information you have provided regarding your wife's illness. Although additional information is needed to evaluate whether the site may pose a health threat to the public, it is important to know what concerns and illnesses are being reported by the community. As with all ATSDR's comparison values, the comparison values for beryllium are conservative levels that should be protective of public health. ATSDR would agree that even lower levels of beryllium might be hazardous to individuals genetically predisposed toward a hyperactive immune response to beryllium. However, it is not possible to quantify the threshold dose of any antigen that would cause adverse health effects in a person hypersensitive to that antigen. Furthermore, it is possible to have sarcoidosis without having beryllium in the lungs. It is also possible to have beryllium in the lungs without having a sensitivity reaction to it that results in granulomatous lung disease. The presence of beryllium in the lungs of a patient diagnosed with sarcoidosis strongly suggests that the patient may have chronic beryllium disease (CBD) masquerading as sarcoidosis. However, a firm diagnosis of CBD requires the demonstration of beryllium hypersensitivity. A clinical test (the beryllium lymphocyte transformation test) is now available that is capable of demonstrating such sensitivity and distinguishing between sarcoidosis and CBD.

Comment 17: In the third paragraph [page 1], ATSDR states, quote, "No adverse health effects are expected from exposure to the contaminants at the concentrations currently

detected in ambient air and are not believed to represent a public health hazard." First off, no contaminants but beryllium have ever been continuously monitored in accordance with federal programs. The EPA RCRA Statement of Basis Corrections in Appendix B confirms the above and suggests that future NESHAP regulations will correct this and additional monitoring requirements will be applied to the NGK Metals for inorganic substances. I believe it is fitting for ATSDR to acknowledge the lack of monitoring in ambient air for other toxics and to support EPA's call for additional monitoring. Secondly, ATSDR is in possession of two documents that cast doubt on the accuracy of laboratory results since 1979 for beryllium in ambient air. I call attention to the letter of Dec. 21, 1992 from Dr. Hugh Archer, Regional Director of the Pa. Dept. of Environmental Resources, and a letter to ATSDR of May 25, 1993, from Catherine Brown of EPA's Region III Environmental Services Division. The first letter from Dr. Archer concludes that the analytical procedure used for 14 years by the contract laboratory hired by the company to analyze ambient air samples for beryllium was determined to be less accurate than another one. The letter from EPA's Catherine Brown concludes, quote, "EPA concurs that the analytical procedure used to determine beryllium concentration in the ambient air samples may not be revealing the total concentration of beryllium, particularly beryllium oxide. Investigation into this issue continues and will notify ATSDR with any conclusions reached." The implications that results have been considerably on the low side are frightening to say the least. But until EPA and Pa. DER complete their investigation and report conclusions ATSDR has absolutely no basis here or any place else in this health assessment to reach conclusions or express opinions about dangers and hazards affecting the population, surrounding and outside the fences of the NGK plant, from beryllium in the ambient air breathed by people.

Response to comment 17: Based upon the air data evaluated by ATSDR, the levels of both beryllium and chromium are not believed to represent a public health hazard. ATSDR will evaluate any air data provided for additional toxics. ATSDR acknowledges that concerns have been raised regarding the analysis of beryllium in ambient air (page 20, under the "Quality Assurance/Quality Control" subsection). As ATSDR also indicates, the data will be evaluated as reported until a final conclusion is reached by EPA. If it is determined that the concentrations are unrepresentative of the actual beryllium concentration in off-site air, ATSDR will reassess the data at that time.

Comment 18: On page 3, final paragraph, exception is taken to the statement that quote, "the plant shut down furnaces that were used for casting and heat treatment of the beryllium metals" and to the following statement, quote, "This process is now primarily cold rolling of metals." I believe that record will show that the plant continues to heat treat and anneal metal alloys and that a major part of plant processes is acid cleaning of the metal alloys. The distinction is important because heat treating, annealing and acid cleaning result in toxic discharges that must be treated satisfactorily or human health hazards may result. The company was heavily fined for improper treatment and handling in recent years resulting in exposure to hazardous substances for both the environment and human beings.

Response to comment 18: ATSDR has revised the public health assessment (page 3) to indicate that NGK only shut down their melting furnaces and hot rolling operations.

Comment 19: On page 4, fourth paragraph, exception is taken to the statement, quote, "That drain field and the Pond 6 waste pile are the only contaminated waste areas that are not currently covered with mushroom soil, pavement, or gravel." Mushroom soil was put down many years ago and is, because of its organic composition, certain to decompose and dissipate, so little if any mushroom soil remains. There are indeed bare areas in the field at the south and southwest areas of the plant and more along the railroad tracks inside the plant. ATSDR notes that the RCRA study produced no surface soil test at the 0-3" depth and until these tests are run I believe it is impossible to say exactly where or where not contaminated areas exist.

Response to comment 19: Information has been provided that indicates that Pond 6 has been consolidated and contained and that the Disposal Area Drain Field is the only area that has not been covered. ATSDR acknowledges some uncertainty as to where contamination of surface soil on-site may exist. Therefore ATSDR recommends (page 45, number 1) on-site surface soil sampling. In light of pending remediation of on-site soils, ATSDR also recommends on-site surface soil sampling subsequent to remedial activities.

Comment 20: Bottom of page 23, under "On-site Soil," on-site workers may have been exposed to toxic substances in the past due to construction and other practices that disturbed the toxic soil; EPA attributes the two violations of the federal standard for beryllium in ambient air out in the community (that NGK was charged with in 1989) to excavation and construction on-site. Respondent checked with OSHA and there is no record that air monitoring was conducted on-site to protect workers during these periods in 1989 when plant soil was disturbed. This health concern merits ATSDR's attention.

Response to comment 20: Indeed, excavation in waste areas for construction or other purposes would also fall within the "On-site Soil," potential exposure pathway. As indicated by the Health Activities Recommendation Panel (page 47), ATSDR has recommended that this assessment "... be referred to the National Institute for Occupational Safety and Health for investigation of work related health concerns."

Comment 21: On page 28, under "Beryllium," ATSDR notes that beryllium is quote, "relatively insoluble." NGK's soil and groundwater has high amounts of fluoride because the plant employed a fluoride ore extraction process to remove beryllium from ore years ago and discarded ore-extracts on the plant site. Much of the beryllium therefore in the soil and groundwater is there as a fluoride; beryllium fluoride is infinitely soluble in water. Acid cleaning residues and spent solutions were also dumped on the plant property accounting for the large amounts of sulfate in the groundwater. Beryllium sulfate formed in the cleaning process is quite soluble. Taking both of the above into account, contrary to the impression

created by ATSDR, much of the beryllium associated with the NGK Metals plant on and off-site is likely to be quite soluble.

Response to comment 21: ATSDR recognizes that beryllium fluoride, as discussed on page 30 of this document (and page 29 of the public comment draft petitioned public health assessment), is soluble. There, its solubility, relevance to the site, and its public health significance are all discussed. On page 28, some of the uses and physical characteristics of beryllium are mentioned as an introduction to beryllium. Beryllium metal, as well as a number of its compounds, including beryllium oxide, beryllium hydroxide, and beryllium carbonate are insoluble or only slightly soluble.

Comment 22: On page 28, also under "Beryllium," fourth paragraph, with documents in hand from government agencies noting that the validity of ambient air monitoring data for beryllium is in serious question and an investigation is under way, ATSDR still endeavors to assure the public that quote, "Levels at other sampling points and during all other time periods was insufficient to pose an elevated cancer risk." The levels are what is now in question - can ATSDR assure the public that those levels will not be raised as a result of EPA's and Pa. DER's investigation? In the same paragraph ATSDR expresses the belief that exposure to four times the federal ambient air standard for beryllium in 1981 (which was repeated incidentally in 1989) is "of no health concern." This respondent would like to see that study data, including data on exposure to beryllium at that level by babies, children and elderly persons, and those with asthmatic conditions, upon which ATSDR bases its belief. Can ATSDR produce such inclusive but essential study data?

Response to comment 22: As indicated in the petitioned public health assessment (page 20) and in the "Response to comment 17," the concern regarding analysis of the data has been raised. The data will be evaluated, as reported, until a final conclusion is reached by EPA. If it is determined that the concentrations are unrepresentative of the actual beryllium concentration in off-site air, ATSDR will reassess the data at that time.

As indicated in the "Off-site Contamination" subsection under "Ambient Air" (page 18), the NESHAPs regulatory standard is based on 30-day averages. Records indicate that NGK and the facility's former owners have only exceeded that standard twice, both times in 1989. For clarification it should be pointed out that ATSDR evaluates data based on public health information, regardless of regulatory limits and violations. In Table 9, ATSDR has noted individual, maximum concentrations for each monitor during each year of sampling.

In addressing public comment number 53, ATSDR again reviewed ambient air data and consequently revised Table 9. In this process ATSDR identified a higher overall individual concentration than the one discussed in the "Toxicological Evaluation" subsection, under "Beryllium" (page 28, of the public comment release draft petitioned public health assessment), to which your comment refers.

The new high value is 0.08143 $\mu g/m^3$ (Table 9), rather than 0.04279 (Table 7 of the public comment release petitioned public health assessment). Given the relatively brief duration of the potential exposure, this higher level should still be of no public health concern. This is not to say that some individual or individuals with a genetically-determined hypersensitivity to beryllium could not possibly have an adverse reaction to extremely low levels of the element or its compounds. However, such a response would, by definition, be unpredictable, i.e., it would be independent of dose in much the same way as that of an allergic response. No standard short of zero, an unattainable goal, could preclude any possibility of such a reaction.

Comment 23: On page 29, third full paragraph, ATSDR notes that quote, "Beryllium levels in off-site soil were determined by a contract laboratory for a citizen and represent a single sampling." Can ATSDR confirm that this is the same laboratory that was hired by NGK to analyze ambient air samples for beryllium and is thus the same laboratory now being investigated by EPA in large part because of the laboratory procedure they have been using to determine beryllium? If so then I believe any conclusions or opinions about the amount of beryllium found in the soil at the citizen's home must await the result of EPA's investigation.

Response to comment 23: The laboratory used to analyze the citizen's soil sample is the same laboratory contracted to analyze NGK's ambient air samples. However, it is our understanding that it is the air sampling procedure rather than the laboratory that is under question and that soil and air sample analyses are conducted differently. Furthermore, 50 additional off-site surface soil samples have been recently collected, analyzed, and evaluated in this assessment.

Comment 24: Under "The chemicals...", in the first paragraph [page 31, number 1], there is this statement, quote, "Fluoride was found in off-site groundwater at elevated levels but these are not high enough to cause health effects under the exposures that are likely to occur." The private well mentioned in the same paragraph had nearly twice the EPA recommended concentration for drinking water. Recently some EPA toxicologist have called into question the advisability of fluoridating water supplies because of health concerns. The mottling of children's teeth and skeletal degeneration are serious health concerns as aired recently over CBS News during which some scientist pointed out the rising health concerns about fluoride in drinking water. Recently EPA decided to reexamine the whole premise of the safety of fluoridating water and is conducting studies. In light of all this I believe it is ill-advised for ATSDR to make any judgements related to health effects from fluoride in drinking water.

Response to comment 24: The fact that an EPA-recommended concentration for drinking water is exceeded, even by 2-fold, does not necessarily indicate that adverse health effects may be expected to result. Health-based standards are not thresholds of toxicity, i.e., they cannot be used to predict adverse health effects. Rather, they are conservative screening

values designed to give public health officials the opportunity to take appropriate actions to protect the public's health before any adverse health effects have occurred.

Excessive fluoride intake over a long period of time can cause dental or skeletal fluorosis. The most sensitive adverse health effect, tooth mottling or dental fluorosis in children exposed during tooth formation, is considered a cosmetic effect that is not necessarily a precursor of skeletal fluorosis. Dental fluorosis may occur at fluoride concentrations as low as 0.8 to 1.6 mg/L. Although precise dose thresholds are not well defined, it has been estimated that daily ingestion of 10-80 mg fluoride for more than 10 years will cause crippling skeletal fluorosis, a serious health effect (52).

Most of the fluoridated water supplies of the largest U.S. cities contain less than 1 mg/L fluoride and most water supplies that are not intentionally fluoridated contain less than 0.3 mg/L (52). Assuming a consumption rate of 2 L/day, concentrations of 1 and 0.3 mg/L would correspond, respectively, to 0.2 and 0.06 mg/kg/day for a 10-kg child, and 0.03 and 0.01 mg/kg/day for a 70-kg adult. Thus, the levels of fluoride in some water supplies may exceed ATSDR's MRL of 0.05 mg/kg/day and may even be sufficient to cause dental fluorosis in some children, particularly when additional sources of fluoride are considered. Indeed, in surveyed cities with water containing 0.7 to 1.2 mg/L (the level to which water is fluoridated), 10-20% of children had barely noticeable changes in their teeth, while up to 1% had brown spots due to fluoride (53). However, the optimal fluoridation of public water supplies has well-established public health benefits for individuals of all ages and socioeconomic groups that justify the continuation of this practice. Nevertheless, in areas with fluoridated water supplies, it may be prudent to avoid additional sources of fluoride, such as toothpaste and other products supplemented with fluoride.

In Reading, Pennsylvania, where public water is not fluoridated, the groundwater that constitutes the public water supply contains only 0.1 mg/L fluoride. With few exceptions, Private well water is below ATSDR's comparison values for lifetime exposure to fluoride. The maximum fluoride concentrations (1700 μg/L) measured in water from the Reading Crest well and public well 1 do exceed one of these comparison values (600 μg/L for children and 2,000 μg/L for adults). However, the Reading Crest Well has never been used as a source of drinking water, and private well 1 was used for drinking water for only 8 years before an alternative water supply was provided. Thus, in the opinion of ATSDR, if no mottling of teeth has occurred as a result of residents' past exposure to the water in private well 1, then no mottling or any other adverse health effect should be expected in the future.

Comment 25: Under "Airborne dust...", the last paragraph on page 31, I find this statement quote, "Pond 6 waste pile and the Disposal Area Drain Field are the only two waste areas on-site that have not been covered." This is simply not true and many bare areas remain subject to releasing air-borne beryllium and other toxics into the air as dust. It's noted that

"no surface soil samples have been taken to characterize the top 3 inches of those waste areas or other potentially contaminated areas." Until there are, there remain potentially contaminated areas not covered.

Response to comment 25: Please refer to the "Response to comment 19" regarding the status of Pond 6 waste pile and discussion about characterization of the site.

Comment 26: Under "Deposition from air emissions...", page 35, second complete paragraph, I take exception to the recommendation that surface soil sampling be conducted "downwind" only. Of the eight air monitoring stations surrounding the NGK plant, at least half are not located in the downwind direction. Yet these also without fail show beryllium deposits every month since monitoring began 14 years ago. The private home where beryllium was found in the lawn soil is not downwind, neither are the residents of the community living closest to NGK's contaminated soil. There has been 50 years of beryllium being emitted from that plant into the community and it had to settle somewhere. I take strong exception to ATSDR's expressed willingness to apparently write off the health concerns of one segment of the population living around that contaminated plant, namely those living in a loosely defined upwind direction.

Response to comment 26: In ATSDR's assessment of this site, we came up with a number of data gaps where information was/is needed in order to determine the public health impact. One of the data needs was off-site surface soil sampling. ATSDR needed a reasonable number of these samples to indicate how much beryllium may exist in the soil and what that data may mean in regard to public health. Fifty off-site surface soil samples were collected and are adequate for ATSDR's evaluation (see pages 30-31 under "Ingestion Exposure" for the toxicological evaluation of that data). Samples were collected downwind (regarding the prevailing wind direction) of NGK, as well as in other directions (see Figure 7 of Appendix A for sampling locations).

Comment 27: Under "There are no air monitors...," page 35, sixth complete paragraph, ATSDR makes the surprising statement that concentrations of beryllium which are representative of on-site ambient air at the southern portion of the site are "likely to be similar to concentrations along Water Street, which is just off-site." This is a remarkable statement since at several places in this Health Assessment and indeed several sentences later, ATSDR decries the fact that the wind direction was not recorded during on-site monitoring and the monitoring was a short, one month event both casting doubt on the validity of the data. If ATSDR's assurances are meant to comfort the people along Water Street, they shouldn't, because the data is meaningless as ATSDR acknowledges. Furthermore, the community concern that ATSDR was responding to was that there are no monitors due south of the plant to protect the residents along Water Street and I do not believe ATSDR's response addressed that concern. There are still no monitors there!

Response to comment 27: The on-site data is very useful as on-site data; however, it provides only limited insight as to what the concentrations are like off-site. Given the information available and having described some of the limitations, ATSDR was able to submit a reasonable evaluation of what air quality just south of the site may have been like during that time period. Data for wind direction during the time period of the on-site sampling has been obtained and included in this document.

Comment 28: Under "Dust carried home...," page 36, last paragraph, ATSDR states that quote, "it is NGK's current procedure to provide protective garments that are collected and to require showers and clean change of clothing at the end of each work day for those employees that might be exposed to beryllium." High management personnel do not take showers, do not change shoes, even though they have walked outside on contaminated surfaces or walked through the plant. It is a fact that ambient air inside the plant and surfaces within the plant contain beryllium and other toxics. ATSDR is in possession of a Pa. DER inspection report that shows beryllium and other toxics coming off roofs and parking lots after a short period of rain. Thus, some personnel could still be carrying beryllium outside the plant on shoes, hair, etc, or on their vehicles.

Response to comment 28: In this public health assessment, ATSDR identified contamination of workers' clothing as a potential completed pathway in the past for family members. ATSDR recognized this as a potential pathway under the assumption that significant amounts of beryllium were being retained on the workers and their clothes. Current exposures to the public, via workers who are following the safety precautions or "high management personnel," appear to be unlikely and will not be considered as a pathway of exposure in this assessment. However, just as stated in the "Response to comment 20," this assessment will be referred to the National Institute for Occupational Safety and Health for investigation of work related health concerns.

Comment 29: Under "Possible health hazards...," pages 37 and 38, beginning with last paragraph on page 37, ATSDR does not respond adequately to the question and concern. In 1989 NGK Metals violated the federal community ambient air standard for beryllium twice, during two separate months, by magnitudes of three and four. The public has never been told and those who live in the vicinity of the monitor with the highest beryllium numbers cannot even alert their doctors if they experience breathing problems, that they may have been exposed to high levels of beryllium. That was the concern ATSDR was asked to address by someone in the community, and the person wanted to know if ATSDR could put out a health advisory.

Response to comment 29: On page 30 (under the beryllium "Inhalation Exposure" subsection), ATSDR discusses on-site and off-site ambient air conditions. Short term exposures to the levels detected in 1989 are not believed by ATSDR to present a health threat.

An ATSDR public health advisory is not simply an announcement of a hazardous substance release, but is notification to other health and environmental agencies when hazardous substances released into the environment pose an immediate and significant danger to people's health.

Comment 30: Under "Orange and green colored smoke...," page 38, sixth paragraph, ATSDR states, quote, "No colored smoke or heavy ash have been associated with the site in recent years." I believe if ATSDR will check with the Pa. DER office in Reading they will learn that complaints about "Orange colored smoke" coming from NGK stacks and acrid smells have been received in recent years by DER from local residents and in fact for a time DER was monitoring the plant by having personnel drive by periodically.

Response to comment 30: The statement, "no colored smoke or heavy ash have been associated with the site in recent years," was a result of a conversation with personnel at the Reading Office of the Pennsylvania Department of Environmental Resources.

Comment 31: Under Conclusion # 3 [page 40], ATSDR notes that quote, "A past completed exposure pathway existed for users of private well 1." Chromium is mentioned. Yet nowhere here or in any other part of this Health Assessment does ATSDR mention that members of the private family who drank unknowingly from their well for eight years have had high levels of chromium in their blood according to extensive medical tests. I believe in a Health Assessment such as this a subject such as that must be included. The subject is not unknown to ATSDR since at the family's request ATSDR suggested a list of doctors and clinics for the family to consult, hence I cannot understand why in this Health Assessment I find no mention of it.

Response to comment 31: ATSDR does not routinely collect or review medical records, although they are sometimes shared with our agency. The medical records of the family referred to above have not been requested, volunteered, or reviewed and therefore are not reported in this document.

In general, biological testing and the results can be important to ATSDR, such as in determining whether exposure has occurred, levels of exposure, and the potential health impact of any exposure incurred. However, tests specifically for chromium exposure are not able to determine the precise levels that an individual may have been exposed to or predict whether health effects will occur (43). In this instance there is a well defined pathway (Off-site Groundwater, pages 21-22) and exposure reported as having occurred.

ATSDR does not provide primary health care and would therefore encourage this family to consult with their private physician, if they have not already done so, regarding any chromium testing they have had conducted.

Comment 32: Under Conclusion # 5 [page 40], ATSDR concludes quote, "Based on an evaluation of the maximum weekly beryllium concentrations detected in ambient air for each year that data are available (1979-93), no increased risk of cancer is expected." Since EPA is now undertaking an evaluation of the results and an investigation of the laboratory that obtained them, I believe it is inappropriate for ATSDR to make such a conclusion until EPA finishes its review.

Response to comment 32: In conducting a public health assessment, it is ATSDR's objective to review the available environmental and health data in order to come to some conclusion regarding the impact that a site or facility may have on public health. ATSDR has evaluated and summarized a wealth of data for the NGK Metals Petitioned Public Health Assessment. The data referred to above have been evaluated by ATSDR, as reported. However, ATSDR has identified (page 20 under the "Quality Assurance/Quality Control" subsection) the concerns and questions regarding the data and has indicated that if EPA renders a decision indicating the data are unrepresentative of the actual air quality, that the data will be reassessed accordingly.

Comment 33: Under Conclusion # 6 [page 41], ATSDR states, quote, "Beryllium in this soil sample is within natural background levels, but could also be related to the site." It is difficult to see how ATSDR can declare the beryllium within background levels when under Recommendation #2 they call for the local background value for beryllium to be determined in the future. If we have no local beryllium background level as yet, how can any value we now received be declared with confidence to be within a value we don't have?

Response to comment 33: As discussed on page 23 (under the "Off-site Soil" subsection of the "Pathways Analyses" section), ATSDR uses background ranges for the eastern United States, which includes samples throughout Pennsylvania. This is used in the absence of more location-specific background data. Local background data would be helpful in characterizing soil conditions and potential site-related impacts. However, based purely upon public health significance, local data will not be necessary, since ATSDR's toxicological evaluation of recent soil sampling indicated that no adverse health effects are expected from exposure to beryllium detected in surface soils.

Comment 34: Under Recommendation # 2 [page 42], ATSDR calls for extensive soil tests and household dust tests, with numerous toxics including beryllium being determined. Under Recommendations # 7 and # 8, ATSDR calls for tests of Laurel Run sediment and fish tissue samples from Laurel Run. I concur with these recommendations but I believe that fish tissue studies must also be done on samples from fish caught in the Schuylkill River at the confluence with Laurel Run. These tests are in essence also called for by EPA in the RCRA remediation order served on NGK Metals nine months ago. According to newspaper accounts recently, after nine months of fruitless negotiations with EPA, NGK has decided to further stall the remediation plan by appeals. Therefore I believe it is incumbent on ATSDR

to recommend that the tests ATSDR deems necessary be implemented by an order on NGK apart from the stalled remediation order. I believe this is possible under the Consent Order setting up the RCRA study which has a provision for further studies.

Response to comment 34: Surface soil sampling has been conducted and evaluated in this assessment (page 31 under beryllium "Ingestion Exposure" of the "Public Health Implications" section) Based upon that evaluation household dust tests will no longer be necessary.

ATSDR will evaluate the analyses of fish tissue from any fish collected in Laurel Run or its confluence. However, at this time, ATSDR is only making recommendations for the sampling of fish from Laurel Run at locations adjacent to and downstream of NGK. Fish tissue sampling, along with a number of other types of environmental sampling, needs to be conducted in order for ATSDR to evaluate the potential public health threat. ATSDR has no authority to "order" or indicate the funding by which fish tissue samples are to be collected.

Comment 35: Under Recommendation # 6 [page43], ATSDR calls for restrictions on properties in EPA's well inventory area and west of EPA's well inventory area extending to the Schuylkill River in regard to groundwater use. I concur that this is absolutely necessary. However, to prevent some family right now or within the next few weeks from moving into this area from far away and drilling a well at an existing home, or building a home and drilling a well, for drinking water purposes, I believe it is essential that ATSDR issue a public health advisory carried in all print media and broadcast by all TV and radio stations serving the area that groundwater in EPA's designated area is absolutely unsafe as drinking water. A special effort should be made to reach all real estate offices also.

Response to comment 35: ATSDR releases public health advisories only in cases where hazardous substances released into the environment pose an immediate and significant danger to people's health. ATSDR has not determined, at this time, that the NGK Metals facility warrants a public health advisory. A public health advisory could be issued in the future if such a determination were made.

Comment 36: ATSDR espouses a worthy goal under 3, final paragraph on page 44, to, quote, "Use this petitioned public health assessment as an educational tool for the community to make them aware of the possible hazards present, the likelihood of exposure, and to assist the community in assessing possible health outcomes associated with exposure to hazardous substances." After a two and one-half year wait and the expenditure of thousands of dollars of public (taxpayers') money the goal is certainly not unreasonable. The goal, however, will not be realized unless ATSDR provides adequate public notice and removes all stops to communicate to the public the availability of the Health Assessment document and the places where it is reposited for the public to review and become educated, so that meaningful public comment and response will ensue. A public notice in the only local newspaper consisting of

a legal notice in fine print that some will need a magnifying glass to read, buried in the back pages next to the obituaries, will hardly serve the purpose. After ATSDR makes a case for the importance of the Health Assessment and spends much time and money to produce it, I find the excuse given for the lack of adequate public notice, "Insufficient funds," totally unacceptable.

Response to comment 36: The final release of the NGK Metals Petitioned Public Health Assessment will be sent to individual citizens on our mailing list in addition to sending the document to the same six repositories used during the public comment period. As is standard procedure, ATSDR will send press releases to the local and regional media sources to announce the release and availability of the petitioned public health assessment. Moreover, in order to ensure adequate public notice, ATSDR will purchase an advertisement in the local paper (Reading Eagle/Times).

Comment 37: In the line of education I find the title page of the Health Assessment to be confusing. Under PETITIONED PUBLIC HEALTH ASSESSMENT I find, Quote, "Cabot-Wrought Products Division of Cabot Corp.," and beneath that, (a/k/a NGK METALS/CABOT BERYLCO, INC). The plant is solely owned by NGK Metals and has been since 1986, long before the health assessment took place. It's not a Cabot plant also known as NGK Metals, it is NGK Metals and it was under the name NGK Metals not Cabot that the plant committed gross violations of state and federal laws that contributed to the conditions now cited by ATSDR as reason to classify the plant as a potential present and future public health hazard as a proven past public health hazard. This brings me to a very crucial public comment related to the Background you define. Included in the site history must be the fact that in 1990 NGK Metals (note: not Cabot) was indicted by the Attorney General for two serious crimes, one a felony, related to violations of the state Solid Waste Laws. Nowhere do I find your mention of this fact that NGK Metals paid heavy fines. The magnitude of these violations can not be over-emphasized. One, the illegal handling and storage at the plant of cadmium cyanide resulted in the loss of enough cadmium cyanide to plant soil and groundwater to contaminate to the federal limit for cadmium more than a billion gallons of drinking water! Cadmium was found by EPA in soil and groundwater during the RCRA study. The second involved the loss of thousands of gallons of toxic waste daily into groundwater and soil on not one but two extended occasions when an underground pipe was broken and not repaired expeditiously. Both these crimes have serious implications for human health yet ATSDR omitted any mention whatsoever in the Health Assessment.

Response to comment 37: The U.S. Environmental Protection Agency lists this site as "Cabot-Wrought Products Division of Cabot Corp." in their Comprehensive Environmental Response, Compensation, and Libility Information System (CERCLIS). ATSDR is required to use the name that is indicated in CERCLIS; however, ATSDR will continue to include the other names by which the site is known (i.e., NGK Metals and Cabot Berylco Inc.).

Regarding your other concerns, it should be noted that ATSDR is not involved in criminal investigation and therefore makes little attempt to describe or enumerate violations of regulatory law. The focus of an ATSDR public health assessment is to evaluate environmental and health data and to assess whether a public health threat exists.

Comment 38: As far as any Public Health Action Plan goes, it is my opinion expressed in my final public comment that while ATSDR has done considerable work resulting in useful information, much more remains to be done. I urge ATSDR to move with all due speed to recommend and pursue those necessary soil, household dust, private well, Laurel Run and Schuylkill River tests. I support a call for studies of disease incidence in the community surrounding the NGK Metals plant. I believe a health advisory is called for in relation to the dangerous and highly contaminated aquifer west of the plant onto the Schuylkill River. It is unthinkable that ATSDR would not take every step possible to notify the public, especially real estate companies, through paid public announcements, that drilling private wells and attempting to use the aquifer for drinking water in the affected area, or the use of existing private wells, could be extremely dangerous to their health. It is my opinion that with all the unanswered questions that ATSDR attributes to lack of data, once that data becomes available ATSDR will be obligated to do a follow-up health assessment.

Response to comment 38: Through the public health assessment process, telephone conversations, meetings, and other written communication, ATSDR has recommended and pursued environmental data that is necessary to evaluate the potential public health threat at this site. Through the Health Activities Recommendation Panel (see page 46), ATSDR has evaluated this document in order to determine what health follow-up (e.g., health studies, etc.) might be appropriate. The concern regarding a public health advisory was discussed in the "Response to comment 35." As described in Numbers 4 and 5 of the "Public Health Action Plan" (page 48), ATSDR will review and evaluate any new data and will revise this petitioned public health assessment as appropriate.

Comment 39: A study recently done at the Universities of Rome and Modena in Italy is reported to show a genetic link to beryllium-related lung disease in human beings who have inhaled the metal, beryllium. It is believed by the researchers led by Luca Richeldi after studying 33 people with this lung disease that a common marker on the genes is responsible for triggering the immunological reaction to beryllium. This finding would seem to have tremendous significance for workers, former workers, and residents living around the NGK Metals plant, many of whom have been exposed to beryllium in the air they breathe and some of whom have developed lung disease. Since it is known that the plant has and continues to, emit beryllium into the air, I believe it is incumbent on ATSDR and the Public Health Service to contact the researchers, discuss application of the study in regard to NGK Metals, and obtain expeditiously a copy of the study. And then do a comprehensive evaluation of lung disease among workers, former workers and residents and former

residents of the community surrounding the plant, not neglecting the families of workers and former workers.

Response to comment 39: Although almost all persons with chronic beryllium disease have the marker in question (HLA-DPß1-Glu^{69}), so do 30% of people without the disease. Thus, while all the subjects in Richeldi's study were exposed to beryllium, one had the disease but no marker, and many others inherited the marker but did not develop the disease. The work of Richeldi and co-workers is an important step towards the identification of a biological marker for beryllium-sensitive genetic constitutions. However, more research is required before a useful biomarker of susceptibility can be characterized. In the meantime, it would not be particularly useful to identify 30% of a workforce as being potentially at risk for a disease that has a prevalence of only 2-5% (33).

Comment 40: It has come to my attention that there has been a development in medical science that I believe has great relevancy to the NGK Metals Health Assessment and should have been included in recommendations for future action by ATSDR. I speak of the Beryllium Lymphocyte Testing, which has the potential to distinguish with confidence those human beings who have been exposed to beryllium and who have retained beryllium in their bodies. As this has been published by ATSDR under the auspices of the U.S. Public Health Service I am at a loss to understand why this was not mentioned in the Health Assessment and furthermore, recommended for widespread use among workers at the NGK Metals plant, families of workers, and residents of the community surrounding the plant. Kindly furnish me with an explanation since both EPA and ATSDR confirm that beryllium has been and is emitted into ambient air not only on-site but off-site. I suggest that along with other recommendations for soil and household dust tests ATSDR also shall recommend wide-spread blood testing of residents of the community, and present and former employees and their families, using the medical testing procedure named above which has already been published by ATSDR. I also recommend that you contact the researcher and developer of the test, Dr. Lee Newman of the National Jewish Center for Immunology and Respiratory Medicine in Denver, and seek his help in locating those individuals already afflicted with beryllium lung disease and those in danger in this area in connection with the NGK Metals Health Assessment.

Response to comment 40: The beryllium lymphocyte proliferation test is mentioned in the "Public Health Implications" section of the final petitioned public health assessment (page 29 under the beryllium "Inhalation Exposure" subsection).

The beryllium lymphocyte proliferation test does not identify people "who have been exposed to beryllium and who have retained beryllium in their bodies." The vast majority of workers who have been exposed to beryllium and have that substance in their lungs do not develop chronic beryllium disease and would not test positive for lymphocyte proliferation in the presence of beryllium. The beryllium lymphocyte proliferation test shows whether or not the

patient has been sensitized to beryllium, thereby enabling the physician to distinguish between sarcoidosis and chronic beryllium disease, which exhibits very similar symptoms.

Since chronic beryllium disease occurs in only 2-5% of exposed workers, it may not be useful to perform a beryllium lymphocyte transformation test on everyone in an asymptomatic, non-occupationally-exposed population. However, any long-term residents who have been diagnosed as having sarcoidosis and who suspect that they may have been exposed to clinically significant levels of beryllium in the past may want to consider consulting an occupational/environmental medicine specialist to determine whether specialized testing for beryllium sensitivity is appropriate.

Comment 41: The ATSDR Assessment concludes preliminarily that the public health hazard is "indeterminate" due to lack of environmental and exposure data for various potentially completed pathways. However, a thorough review of the analytical data and consideration of the cumulative impact of NGK's environmental improvement projects supports a conclusion that the facility does not pose a significant public health hazard in any respect.

Response to comment 41: Based upon data reviewed by ATSDR, no public health hazard exists. In addition, ATSDR does not consider other media and exposure pathways likely to present a public health threat; however, additional data and information are needed before such a conclusion can be reached.

Comment 42: The ATSDR Assessment includes numerous statements of a hypothetical or speculative nature which are presented in the midst of discussions concerning health risks. Such statements are at best confusing to the reader and, more often than not, imply that these are real and substantial risks even though the data do not support any such conclusions. The final version of the Assessment should correct these misimpressions by deleting speculative material, especially where it appears in summaries, conclusions and recommendations. This is especially necessary in light of the stated purpose of using the Assessment "as an educational tool for the community" (page 44). Obviously, the educational aspect is undermined if the community is not provided with a document which carefully distinguishes between fact and speculation.

The Summary contains statements that are not supported by the data or site conditions as described in the body of the Assessment. For example, references to a potential slight risk of cancer at an off-site surface soil location is inappropriate where the contaminant discussed (beryllium) is not an oral carcinogen and where the concentration is below acknowledged background levels. References to the site as an "indeterminate public health hazard" is also inappropriate for reasons discussed below. The Summary should instead state that the site does not pose a public health problem given the data and improved site conditions.

Response to comment 42: Based upon public comments, new data and information, and current toxicological research, ATSDR has made necessary revisions to this final petitioned public health assessment. ATSDR has evaluated the available data and reported the relevant facts as known. Where appropriate, ATSDR has discussed the likelihood of certain exposures and adverse health effects. Therefore, ATSDR believes this petitioned public health assessment is a useful tool by which to make people aware of the possible hazards present, the likelihood of exposure, and to assist them in assessing possible adverse health outcomes associated with exposure to hazardous substances.

Comment 43: ATSDR identifies "contaminants of concern" in various media by comparison of the maximum concentration of the substance with the "comparison value". Since maximum concentrations typically reflect "hot spots" or localized conditions (or even sampling anomalies), this approach presents an artificial and biased picture of potential risk. The Assessment should instead use average or median concentrations to identify potential problems and the reports findings and conclusions should be revised to reflect the results of comparisons based upon average or median concentrations.

Response to comment 43: The point is well taken; however, as a public health agency, ATSDR takes a conservative approach in order to protect public health. Therefore, ATSDR evaluates the maximum concentration to which a person might be exposed. Averaging sampling concentrations is most useful when representative sampling has been conducted and is analyzed by a statistical approach. Although ATSDR guidance does not exclude using averaged data, it calls for the range of concentrations to also be included. ATSDR guidance explicitly specifies the following, "For the purpose of selecting contaminants of concern, the maximum concentration of a contaminant should be used. This ensures that all potentially significant contaminants will be evaluated."

Comment 44: Page 4 "A. Site Description and History"
The Pond 6 waste pile and the Disposal Area Drain Field are identified as the "only contaminated waste areas that are not currently covered with mushroom soil, pavement, or gravel (page 4, paragraph 4). The Pond 6 waste pile is no longer an area of concern because the Pond 6 dirt pile has been relocated to the south east quadrant of the facility as part of corrective measures implementation and capping activities at the facility. Accordingly, this material should no longer be considered a source area.

Proposed revision: Delete last two sentences of third paragraph, page 4, and insert: "As part of corrective measures currently being implemented at the site, this material has been relocated, consolidated and contained on the southeast quadrant of the facility to minimize potential exposure."

Revise the last sentence of paragraph four as follows: "That drain is the only contaminated waste area that is not currently covered with mushroom soil, pavement, or gravel (2,3)."

Similar changes should be incorporated throughout the report wherever reference is made to Pond 6 (see, e.g., page 12).

Response to comment 44: Given that information, ATSDR has changed the discussions in this document, regarding Pond 6 waste pile, to reflect the fact that it has been relocated and covered.

Comment 45: Page 5 "B. Site Visit"
NGK's active landfill is a residual waste landfill. Since no hazardous wastes as defined by RCRA have been placed in the landfill, a RCRA permit is not required for this area. The landfill is permitted under the Pennsylvania Department of Environmental Resources residual waste regulations. Paragraph 2, page 5, should be corrected to reflect this.

The acid neutralizing tank referenced on this page is part of a process water conditioning line. This tank is discharged through the wastewater treatment plant and, as such, is not a separate waste area.

Response to comment 45: ATSDR has corrected the notation that indicated that the landfill operated under a Resource Conservation and Recovery Act permit to reflect the fact that it operates under the Pennsylvania Department of Environmental Resources residual waste regulations. Regarding the acid neutralizing tank, ATSDR does not define it as a separate waste area, but merely mentions it as something that was identified and discussed during the NGK site tour.

Comment 46: Page 11 "ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS," "Contaminants of concern," Comparison Values
The Assessment does not indicate the basis for the Comparison Values. At least some of the values that are presented cannot be supported scientifically. ATSDR should provide the basis, origin and derivation for all comparison values in order to allow for meaningful public comment. This is essential for values which, to NGK's knowledge, are not published in the readily available literature (e.g. CREG, EMEG, EPA III, IEMEG, and RMEG).

The beryllium comparison value for drinking water is reported in the Assessment as being 0.008 ug/l (CREG). EPA recently promulgated the drinking water MCL and MCLG for beryllium at 4.0 ug/l, 57 Fed. Reg. 31776 (July 17, 1992), concluding that "the dose response analysis for ingestion exposure does not provide adequate evidence of carcinogenicity from a drinking water source." Accordingly, ATSDR should use a comparison value of 4.0 ug/l (or ug/kg) for beryllium in oral exposure pathways. Apparently, the CREG for beryllium in soils is also based upon the now discredited notion that beryllium is an oral carcinogen. If so, this value should not be used in the final Assessment.

Similarly, the comparison value for chromium is inconsistent with the MCL and MCLG, as established under the Safe Drinking Water Act. The chromium comparison value in water should be established at 100 ug/l, the MCL and MCLG for chromium. 56 Fed. Reg. 3526 (Jan. 30, 1991)

We cannot provide meaningful comment on other comparison values, including the comparison values for chromium and beryllium in other media, without information concerning the origin and calculations of those values. ATSDR should provide information concerning the origin of the comparison values and allow for additional comment on those values.

Response to comment 46: In Appendix C, ATSDR lists the names of the comparison values used, the source of derivation, and gives a brief description of the comparison value. Comparison values used by ATSDR are health-based values and may not reflect regulatory standards, which sometimes consider other factors. For example EPA's Maximum Contaminant Levels (MCLs) do not strictly represent health-based concentrations, since the availability and economics of water treatment technology is also considered in determining those levels. ATSDR uses MCLs in the absence of more stringent, health-based comparison values.

ATSDR discusses the issue of beryllium as an oral carcinogen on pages 30-31 (under beryllium the "Ingestion Exposure" subsection). In that discussion, ATSDR identifies the study, and its limitations, that is used by EPA to develop an oral cancer slope factor. ATSDR develops Cancer Risk Evaluation Guides (CREGs) for each chemical that has a published cancer slope factor. Therefore, ATSDR will continue to screen beryllium in this manner. However, further toxicological evaluation will be conducted to make a final determination, just as has been done in the "Public Health Implications" section of this petitioned public health assessment.

As discussed in the "Environmental Contamination and Other Hazards" section (pages 10-11), comparison values are "used to select contaminants for further evaluation." Comparison values are used by ATSDR as guidelines for screening purposes and are not predictors of adverse health effects. Contaminants selected as *contaminants of concern* are evaluated further for potential health effects, in the "Toxicological Evaluation" subsection (page 27). In that subsection, ATSDR considers numerous medical, toxicologic, demographic, and environmental factors in evaluating contaminant concentrations and the impact they may have on public health.

The public comment process is intended to address comments regarding this document. If you have further questions regarding ATSDR's use of comparison values you may refer to the ATSDR Public Health Assessment Guidance Manual and/or contact ATSDR for a direct reply.

Comment 47: Page 14 "B. Off-site Contamination," "Soil"
There are no Quality Assurance or Quality Control protocols referenced with the off-site soil sample taken on November 18, 1992. If these protocols were not followed or are not available, the validity of this sample must be questioned and its use for evaluative purposes should be appropriately limited. Also, there is no information concerning the sample location or soil type (e.g. native soil versus fill material).

Response to Comment 47: The public health evaluation of off-site surface soil in this version (final) of the NGK Metal Petitioned Public Health Assessment does not rely solely on the above mentioned sample. Fifty other samples were also evaluated.

Comment 48: Page 17 "Ambient Air"
The excursions of the NESHAPS occurred during the excavation of a large area of red mud for the construction of a new building. No drain line excavation occurred during this time frame. The text should note that this was a one-time event.

Response to comment 48: ATSDR has revised the public health assessment (page 18 under the "Ambient Air" subsection) to indicate that violations of the NESHAP during June and August 1989 occurred during the excavation of red mud for the construction of a new building.

Comment 49: Page 19 "C. Quality Assurance/Quality Control"
As the Assessment notes, the reported results of surface water sampling in 1981 for beryllium and manganese are highly suspect. It is thus improper from a scientific standpoint to accept those results and use them to draw conclusions regarding current stream conditions (especially where data in the intervening 12 years conflicts with the 1981 results). ATSDR should not accept the anomalous 1981 data and should revise the Assessment in keeping with the more recent data.

Response to comment 49: The 1981 surface water sampling is discussed in the "Quality Assurance/Quality Control" subsection because a possible reporting error was suspected due to inconsistency with other surface water data. However, ATSDR indicates that there is an 8-10 year span between the results being compared, during which time surface water quality may have greatly improved. ATSDR has included the 1981 surface water concentrations as reported, since there is no definitive evidence indicating a reporting error and since there are no other compelling reasons to warrant omission of the data. Furthermore, since ATSDR primarily focuses its assessment on current and future public health issues, the most recent data is used when determining what health threat may currently exist while older data generally provides a historical perspective on contamination.

Comment 50: Page 20 "C. Quality Assurance/Quality Control"
The air flow of the ambient air samplers is checked and recorded on a daily basis to ensure a constant velocity and sampling volume. This procedure has been followed since air monitoring commenced. If need be, adjustments are made to maintain an air flow of 45 cubic feet per minute (CFM). Factors such as particulate loading and humidity can affect the sampler flow rate. If flow drops below 35 CFM, the filter and/or sampler is replaced as necessary. The text should be modified to make more explicit that the questions raised about data quality have been addressed by company procedures.

Response to comment 50: The questions raised do not necessarily involve whether the samplers are checked and maintained on a daily basis, but rather the quality of the data that results from low flow (below 39 cubic feet per minute [CFM]) or when pumps shut down between daily flow checks.

Comment 51: Page 21 "A. Completed Exposure Pathways," "Off-site Groundwater"
When using 100 ug/l as the appropriate comparison value for chromium, as discussed above, no contaminants were detected at a level of concern in private well 2. Furthermore, considering that private well 1 has been disconnected, it cannot be considered to be a present or future completed pathway. The text should be revised accordingly so that there are no erroneous statements concerning completed pathways.

Also, Table 9 should be modified to show that private well 1 does not present an exposure threat and to delete private well 2 because there is no basis for concluding that there is a completed past, present, or future exposure pathway with respect to that well.

Response to comment 51: ATSDR uses a comparison value of 50 μg/L for chromium in drinking water. The text in the "Completed Exposure Pathways" subsection does not indicate that private well 1 represents a present and future completed exposure pathway. Table 11 (Table 9 of the public comment release petitioned public health assessment) has been revised to indicate that present and future exposure pathways, under "Off-site Groundwater," applies only to users of private well 2.

Comment 52: Page 22 "On-site Ambient Air"
The section discussing "On-site Ambient Air" appears to confuse issues related to on-site and off-site ambient air. All available data clearly show that on-site ambient air complies with OSHA limits. Accordingly, there is no basis for concluding that on-site workers are subjected to any risk that is different from the off-site ambient air pathway. ATSDR should clarify that on-site workers are not exposed in exceedance of the OSHA limits. The discussion concerning off-site ambient air in this section is confusing and highly speculative and therefore should be deleted.

During Pond 6 soil excavation, key contractor employees were monitored for beryllium exposures. No employee monitored was exposed to beryllium concentrations exceeding the OSHA criteria. During this period, no abnormal beryllium concentrations were detected in NGK's ambient air monitoring network. Accordingly, there is no basis for concluding that the continuing corrective actions will create any exposure risk.

Response to comment 52: ATSDR acknowledges that there are no data indicating that on-site workers are exposed to contaminant levels that exceed Occupational Safety and Health Administration (OSHA) limits. OSHA limits are established based upon exposures that would occur during a typical work week (i.e., 8 hours a day or a 40 hours a week). In the context of discussing on-site ambient air and worker exposures, ATSDR finds it necessary to identify the fact that on-site workers who live near the plant may also be receiving additional site-related exposures when they are at home, which would be in excess of the 40 hours a week upon which OSHA's health standard is based. ATSDR has record of individuals who have reportedly worked at the plant and lived nearby. In such instances, ATSDR's Cancer Risk Evaluation Guide (CREG) would apply.

Contrary to your comment that "there is no basis for concluding that on-site workers are subjected to any risk that is different from the off-site ambient air pathway," Table 10 indicates that on-site ambient air concentrations for beryllium are typically higher than ambient air concentrations just off-site.

Comment 53: Page 22 "Off-site Ambient Air"
In Table 7 the data has been incorrectly used in instances where there are multiple samples for a 7 day period. Typically, filters are changed weekly providing weekly beryllium concentrations. Occasionally, filters must be changed more frequently due to filter loading or equipment problems. NGK then provides EPA with separate concentrations for each filter, i.e. one representing the beryllium level for the first half of the week and the other for the latter part of the week. In tabulating the data, ATSDR has added these two numbers and reported the sum of the numbers as the weekly maximum. This grossly overstates the ambient concentration because concentration values are not additive. A more appropriate method would be either to select the higher of the two values, or to add the total mass of beryllium found on the filters and divide by the total volume sampled. Using the data in this manner would show that for the first two months of 1993 no sampling stations are above the comparison value. ATSDR should review all data to ensure that calculations have been made correctly.

Decreases in ambient air concentrations have occurred since process changes at the facility. ATSDR classifies these decreases as not "substantial," without basis. Recent concentrations for beryllium (see Table 7), if calculated correctly, would show that beryllium has been below the comparison value at all off-site sampling stations for the first two months of 1993. As can be seen from this data, even an insubstantial decrease lowers beryllium levels below

the comparison value. Accordingly, ATSDR should conclude that there is not a reasonable likelihood of future exposures. This is particularly true in the long term considering the corrective actions being undertaken at the site.

As the Assessment notes (page 12), there are a number of chromium emission sources in the Muhlenburg Township and Reading area. It is thus inappropriate to state throughout the Assessment that there is a completed pathway for chromium attributable to the NGK plant. When the following beryllium concentrations are compared to chromium at the NGK sampling stations, it is apparent that the chromium concentrations detected are from a source other than NGK since there is no correlation between the beryllium and chromium concentrations.

Station R1

Date			Beryllium ug/Filter	Chromium ug/Filter
Nov	17	92	2.38	34.8
Nov	24	92	1.86	88.1
Dec	01	92	0.695	5.79

Station R-2

Date			Beryllium ug/Filter	Chromium ug/Filter
Nov	17	92	1.41	36.4
Nov	24	92	2.33	41.8
Dec	01	92	1.55	14.2

Station R-3

Date			Beryllium ug/Filter	Chromium ug/Filter
Nov	17	92	1.39	50
Nov	24	92	2.0	37.3
Dec	01	92	0.802	13.3

Station R-4

Date			Beryllium ug/Filter	Chromium ug/Filter
Nov	17	92	1.58	200
Nov	24	92	0.211	33
Dec	01	92	0.703	9

Station R-5

Date			Beryllium ug/Filter	Chromium ug/Filter
Nov	17	92	1.22	5
Nov	24	92	1.8	31.3
Dec	01	92	0.691	26.2

Station R-6

Date			Beryllium ug/Filter	Chromium ug/Filter
Nov	17	92	1.46	42.3
Nov	24	92	1.67	50.7
Dec	01	92	0.523	41

Station R-7

Date			Beryllium ug/Filter	Chromium ug/Filter
Nov	17	92	1.23	40.9
Nov	24	92	2.07	16.2
Dec	01	92	0.538	7.5

Station R-8

Date			Beryllium ug/Filter	Chromium ug/Filter
Nov	17	92	1.25	5
Nov	24	92	1.67	18.8
Dec	01	92	0.428	21.2

The Assessment indicates that ATSDR "believes" that chromium exposures are occurring based upon a single chromium sample in 1991 that cannot be attributed to NGK's operations.

This sort of speculation is unwarranted and unscientific, and the text should be revised to delete all references to chromium as a completed air pathway.

As an informational matter, only the melting furnaces and hot rolling operations were shut down during November 1992. Current plant operations include pickling, mechanical cleaning, slitting and anneal furnaces.

Response to comment 53: After again reviewing the original data sheets, ATSDR made some corrections and changes to Table 9 (Table 7 of the public comment release petitioned public health assessment). Most changes involved referencing the number of days monitors operated in order to obtain the concentrations reported. Prior to 1990 NGK Metals and its former owners reported the dates that air sampling began and ended. This practice was conducted even when filters had to be changed during the week due to filter loading or equipment problems. However, since that time NGK reported only the beginning and ending dates of the routine sampling week, even when filters were changed between those dates. Rather than adding the concentrations, as done in Table 7 of the public comment draft assessment (Table 9 in this document), ATSDR has reported the maximum concentration per number of days sampled. Instances where the actual number of days are not known, are referenced as such. In addition, ATSDR has updated Table 9 through 1994 and revised document text (pages 17-18 and 22), as necessary.

Ambient air data for 1993 and 1994 continue to reveal concentrations that exceed the comparison value. Comparison values are used by ATSDR as health guidelines to select *contaminants of concern* for further toxicological evaluation. Under the "Off-site Ambient Air" subsection in the public comment release petitioned public health assessment (page 22) it should not have been implied that the exceedance of the comparison value constituted a future pathway. A future pathway exists because there is a source of contamination, an environmental media to transport contamination, and a point and route through which a population can be exposed. Despite changes in plant operation, beryllium is still being detected in off-site ambient air; therefore, a future completed pathway is expected to exist.

Chromium has been detected in NGK's wastewater discharge (Table 7) and on-site subsurface soil samples (Table 2) as evidence that chromium has been a part of NGK's waste stream. Chromium air concentrations were revealed through sampling conducted at two on-site monitors (at ground level) and an off-site monitor during a five week period in July 1991 (see page 13 and Table 10). Reference 2, "Human Health Evaluation and Ecological Assessment," indicates an air exposure pathway for chromium through fugitive dust emissions from the Disposal Area Drain Field. Given the prevailing wind direction and close proximity of the Disposal Area Drain Field to the properly lines, ATSDR does not believe that fugitive dust emissions would remain on-site. The November-December 1992 data submitted in the above comment does not show any clear or consistent pattern (even with wind data for the dates sampling was reported)(9). However, since the second highest

concentration in that data set is found at the R1 monitoring station, located adjacent to the site, it would not wholly support the commenter's notion that NGK is not a chromium source.

ATSDR has revised the "Site Description and History" (page 3) and the "Off-site Ambient Air" subsections (page 23) to properly indicate that only the melting furnaces and hot rolling operations were shut down.

Comment 54: Page 23 "Residential Soil"
ATSDR correctly indicates that the levels of beryllium detected off-site are below those that may occur naturally in the region. Also, as stated previously, the beryllium drinking water comparison value is overstated because beryllium has not been shown to be an oral carcinogen. Accordingly, it is not reasonable to conclude that there is a "particular concern" for off-site residents due to soil levels.

Response to comment 54: Beryllium in off-site surface soil is not expected to pose any public health threat, based upon ATSDR's current, further, toxicological evaluation of beryllium concentrations detected in off-site surface soil.

Comment 55: Page 24 "Off-site Soil"
As discussed above, the soil data for the residence where private well 1 is located is of questionable value. Also, as discussed by ATSDR, this soil demonstrates levels of contaminants equivalent to levels occurring naturally in the area. Because existing data show that no significant impact exists at the residence, ATSDR should not speculate that impacts may exist at other locations.

Response to comment 55: During recent off-site surface soil sampling, beryllium (as well as chromium) was detected at 11 other locations. Based on that data, ATSDR changed the "Off-site Soil" pathway from potential to completed.

Comment 56: Page 26 "Off-site Biota"
ATSDR notes that metals, particularly beryllium and copper, are not readily bioconcentrated. In fact, these metals are not readily absorbed, much less concentrated. Accordingly, it is extremely unlikely that any potential exists for exposure through the consumption of biota. The text should be revised to state that ingestion of biota does <u>not</u> present a significant potential for exposure. Also, the text should be revised to delete all speculation concerning ingestion (e.g. references to "contaminated food" when there is no evidence of same).

Response to comment 56: Under "Off-site Biota" in the "Potential Exposure Pathways" subsection (page 26), ATSDR has defined a potential pathway of exposure. That subsection contains discussion regarding the media, that are known to be contaminated, by which plants and animals (namely fish) may result in contamination and then be eaten by humans.

ATSDR has attempted to make readers aware of the fact that some metals are not readily bioconcentrated, accumulation of metals does occur. ATSDR would even agree that significant exposure appears unlikely; however, in the absence of actual data no definite public health determination can be made. Therefore, fish tissue samples are recommended to determine whether actual contamination has occurred and to evaluate whether any potential health threat exists.

Comment 57: Page 28 "PUBLIC HEALTH IMPLICATIONS," "Beryllium"
ATSDR clearly states that beryllium does not present a health concern in on-site ambient air, off-site ambient air, off-site groundwater and off-site soil. Considering that this directly addresses the concerns of the community, this conclusion should be included in the summary of the document.

It should be noted that ATSDR is incorrect in stating that EPA has developed guidelines for an ingestion cancer risk for beryllium. As discussed above, EPA has determined that there is no basis for concluding that ingestion of beryllium poses a risk of cancer. Considering that EPA has concluded that no ingestion risk exists, and considering that beryllium is not absorbed, there is no basis for concluding that the off-site residents at private well 1 have any increased risk of cancer. This is particularly true considering that the reported concentration of beryllium was not significantly higher than the Safe Drinking Water limit and that any exposure to well water has been eliminated with the connection of that residence to the public water supply.

Response to comment 57: Beryllium does not present a public health hazard, based on data reviewed, in on- and off-site ambient air, off-site groundwater, and off-site soil. The current summary reflects that conclusion.

EPA does have an oral cancer slope factor (4.3) for beryllium. This is discussed in the "Response to comment 46" (second paragraph) and in the "Ingestion Exposure" subsection (page 30). ATSDR's approach; however, is not one that relies solely on a single number, but considers numerous medical, toxicologic, demographic, and environmental factors in evaluating contaminant concentrations and the impact they may have on public health.

Comment 58: Page 30 "Chromium" and "Volatile Organic Compounds (VOCs)"
It appears that ATSDR does not find any existing health threat from exposure to chromium or VOCs, considering that private well 1 has been closed. ATSDR should clarify this point. This should also be reflected in the Assessment summary.

Response to comment 58: In the discussion of "Chromium" and "Volatile Organic Compounds," ATSDR mentions that an alternative water supply was provided and that the well is no longer used. ATSDR no longer believes that past exposures in private well 1 were likely to result in adverse health effects.

Comment 59: Page 40 "CONCLUSIONS"
Conclusion 2. Conclusion 2 is confusing considering that ATSDR appears to clearly indicate that existing data do not show a threat to health. Moreover, the major environmental improvements that are either completed or underway (e.g. upgrade of wastewater treatment plant, impervious capping of potential source areas) provide substantial additional protection. Accordingly, ATSDR should clarify this conclusion to indicate that existing data and site conditions show no threat to public health.

Conclusion 3. ATSDR appears to base its cancer risk assessment on a life-time exposure scenario. Considering that private well 1 has been closed, there is not a reasonable basis to conclude that there is an increased risk of cancer.

Conclusion 5. The statement concerning child exposure is purely speculative and should be deleted from this conclusion.

Conclusion 6. ATSDR presents an "extremely unlikely scenario" as a creating a "slight increase in cancer risk." Considering that EPA has concluded that the evidence does not support the conclusion of an ingestion cancer risk from beryllium, there is no basis to conclude that there would be an increased risk of cancer even under ATSDR's extremely unlikely scenario. Thus, this "conclusion" is speculative and should be deleted.

Conclusion 7. Existing data provide sufficient basis for ATSDR's "Toxicological Evaluation," which concludes generally that there are no present health risks. Accordingly, further data is generally not necessary.

Response to comment 59: Conclusion 2. Throughout the document ATSDR clearly and directly states that further data are needed in order to complete ATSDR's evaluation. Data gaps are listed on page 44 and the recommendations on page 45 indicate the data requested to complete this evaluation.

Conclusion 3. ATSDR has reevaluated the past exposure in private well 1 to 1,1-dichloroethene, as well as chromium, and has determined that no adverse health effects are expected. Conclusion 3 from the public comment release petitioned public health assessment has been deleted.

Conclusion 5. ATSDR has eliminated the hypothetical exposure used in Conclusion 5 of the public comment release petitioned public health assessment.

Conclusion 6. Although EPA does have an oral cancer slope factor for beryllium, ATSDR's current toxicological evaluation of beryllium in off-site soil indicates that no adverse health effects are expected. Conclusion 6 was not included in this document.

Conclusion 7. Although ATSDR believes that other media and exposure pathways appear unlikely to pose a public health threat, definite conclusions cannot be made about without fulfilling current data gaps.

Based on the data reviewed by ATSDR, additional data are needed to evaluate potential on-site soil, off-site soil, off-site groundwater, off-site sediment, and off-site biota pathways.

Comment 60: Page 42 "RECOMMENDATIONS"
Recommendation 1. These areas are being addressed by the RCRA corrective action measures currently being undertaken. Thus, additional surface sampling is not necessary.

Recommendation 2. Existing residential soil samples do not show elevated levels of contaminants. Considering that off-site ambient air does not present a health risk, there is no basis for concluding that off-site soils will be contaminated. Accordingly, off-site soil sampling is not warranted.

Recommendation 3. For the reasons discussed above, even under a worst case scenario, there is no basis for concluding that the soils at the private well 1 residence present a health risk. Therefore, there is no basis for further characterization of those soils.

Recommendation 4. The current EPA well inventory area covers a sufficient area to identify all wells with any reasonable potential to be impacted by the site. Accordingly, there is no basis for further efforts to survey wells. Moreover, as part of the RCRA corrective measures work, NGK will be pumping and treating groundwater.

Recommendation 6. The proposal to restrict non-NGK properties is vague and not supportable on the basis of groundwater data.

Recommendation 7. Upstream and downstream sediment samples were collected in Laurel Run during the RCRA Facility Investigation. See Table 8. These samples do not present a health risk. Thus, collection of more samples is not warranted.

Recommendation 8. ATSDR correctly notes that contaminants of concern that may be present in Laurel Run are not readily bioabsorbed. Therefore, there is no reasonable basis to conclude that fish in Laurel Run may be contaminated. Furthermore, if it is assumed as an extreme case that fish have absorbed some minimal concentration of contaminants of concern, no health threat is likely due to the low bioavailability of these contaminants.

Response to comment 60: Recommendation 1. The request for on-site surface soil sampling, though not as important now as when the draft assessment was written, based upon comments identifying the relocation and covering of the Pond 6 waste pile and pending remediation, is still recommended. This sampling should be considered in order to evaluate

current contamination of on-site surface soil. Further, to evaluate the effectiveness of remediation and any future potential health threat, ATSDR recommends representative on-site surface soil sampling to establish a baseline subsequent to remedial activities. Recommendation 1 has been revised to reflect those needs.

Recommendation 2. Ambient air data is present only since 1979 and that data shows that beryllium is detected in off-site ambient air, although not at levels of concern. The likelihood for migration of beryllium through the deposition of air emissions and fugitive dust during the plant's operation (1935-present) warranted off-site soil sampling. Fifty additional off-site surface soil samples were collected and analyzed for beryllium and chromium. Those samples were evaluated and are not expected to result in any adverse health effects; therefore, Recommendation 2 was revised accordingly.

Recommendation 3. Recommendation 3 from the public comment release petitioned public health assessment has been deleted based upon ATSDR's current evaluation of off-site surface soil data.

Recommendation 4. Based upon the geology of the area, location of off-site wells monitored, and the concentrations of site-related contaminants found in those wells, ATSDR believes there is reasonable basis for recommending that the well survey be expanded as described in Recommendation 3 of this document (Recommendation 4 of the public comment draft petitioned public health assessment). Recommendations 3 and 5, of this document, are needed until the corrective measures described in the comment, or some other action, is taken to ensure the protection of public health from contaminated groundwater supplies.

Recommendation 6. Figure 8, in Appendix A, shows the EPA specified well inventory area. Properties between that area and the Schuylkill River (which is not completely shown on Figure 8) are also being referred to in Recommendation 5 (Recommendation 6 of the public comment release petitioned public health assessment). Although it is likely that the EPA specified well inventory area indicates the area of primary contamination, it is ATSDR's concern that migration could occur much further west and that contamination could be drawn toward the Schuylkill River. Geological factors, such as karst formations, which are not characteristic of uniform flow and migration, in part, give rise to ATSDR's concern. Tables 4a-4c, in Appendix B, show that the westernmost wells located within the EPA specified well inventory area (see Figure 8), contain varying concentrations of site-related contaminants. ATSDR does not believe that the data sufficiently shows the extent (west) to which contamination may migrate. Therefore, as an initial matter to address ATSDR's concern, Recommendation 3 has been made.

Recommendation 7. ATSDR is requesting additional sediment sampling primarily due the presence of "unusual sediment" that was collected and analyzed (see page 17 under the "Sediments" subsection), as a solution, in September 1991, several months after the most

recent sediment sampling was collected (i.e., sampling conducted under the Resource Conservation and Recovery Act Facility investigation in June 1991).

Recommendation 8. The need for fish tissue sampling is based on community concerns which report that fish from Laurel Run have been consumed, as well as the fact that ATSDR attempts to consider the impact of multiple exposure pathways.

Most metals are bioconcentrated to some degree. The levels of metals concentrated in fish are dependent on any number of factors, including: the characteristics of the metal, availability of the metal, and types of fish and their feeding habits. Suckers are a bottom feeding fish, which increases their potential for contamination. Lead and copper in particular were detected in NGK's wastewater discharge at levels that warrant some consideration of the biota pathway. Therefore, ATSDR maintains its recommendation for fish tissue sampling.

Comment 61: That the dose/duration of beryllium is not as important to berylliosis, or chronic beryllium disease as a person's sensitivity.

"...individuals exposed to high concentrations over a shorter period of time could have a total lung burden of beryllium as great or greater than individuals exposed for a longer period of time to lower concentrations."[1]

"Some of the berylliosis cases at Lorain developed after
many years of exposure, but most of them developed after relatively short periods. Of the 21 cases, 18 (86%) were employed for six months or less."[2]

"Chronic beryllium disease continues to occur in the nonoccupational setting and among bystanders in industry, masquerading as sarcoidosis. Because even transient or possibly low levels of exposure may cause disease, this case has important implications for how clinicians, industry, and' government agencies define the populations at risk of chronic beryllium disease."[3]

"Five workers at a precious metal refinery developed granulomatous lung disease between 1972 and 1985. The original diagnosis was sarcoidosis, but 4 of the workers were subsequently proved to have hypersensitivity to beryllium..." "Review of medical records of coworkers and extensive industrial
hygiene surveillance of the plant demonstrated that 4 cases occurred in the furnace area where air concentrations of beryllium fume were consistently below the permissible exposure limit of 2 mg/m^3."[4]

[1] Wagoner JK. Infante PF. Nancuso T. Letter re. Beryllium Carcinocenicity Studies. *Science* 1978 July 28;Vol 201:298-300

[2] Eisenbud M. Lisson J. Epidemiological aspects of beryllium induced nonmalignant lung disease: a thirty year update. *Journal of occupational Medicine 1983* 1983 March;Vol. 25 No. 3:196-202

[3] Newman LS. Kreiss K. Nonoccupational beryllium disease masquerading as sarcoidosis: Identification by blood lymphocyte proliferative response to beryllium. *American Review of Respiratory Disease* 1992 May;145 (5):1212-4

[4] Cullen MR. Kominsky JR. Rossman MD. Cherniack MG. Rankin JA. Balmes JR. Kern JA. Daniele RP. Palmer L. Naegel GP. et. al. Chronic beryllium disease in a precious metal refinery. Clinical epidemiologic and immunologic evidence for continuing risk from exposure to low level beryllium fume. *American Review of Respiratory Disease* 1987 Jan;135 (1):201-8

Response to comment 61: The final document includes reference to the potential for chronic beryllium disease to be misdiagnosed as sarcoidosis. It also points out the value of the beryllium lymphocyte proliferation test in distinguishing between the two diseases. All of the cases reported by Cullen et al. (1987) were occupationally exposed to levels in excess of the 0.01 ug/m^3 standard for ambient air around factories. Generally, non-occupationally exposed individuals who develop chronic beryllium disease in response to very low levels of beryllium represent a hypersensitive subset of the population. The immune response of these individuals to beryllium is similar to an allergic reaction in that it appears to be largely independent of dose. The "safe" exposure level for such hypersensitive individuals is presently unknown and, practically speaking, may be unattainable. This hypersensitive subset of the population may someday be identifiable through specific biomarkers of susceptibility on their lymphocytes (33). However, research on the subject has not yet progressed to the point that would make that a practical option at this time (see response to Comment 39).

Comment 62: That the charts are confusing, and that the amounts of beryllium found in and around NGK are magnitudes higher than ATSDR's comparison values.

Instead of using all the different comparison values listed for the different elements, I tried to simplify by noting the amount above the comparison values when they were higher, and a percentage of the comparison values when lower. (I used "X Value" instead of "times comparison value")

SURFACE SOIL

ON-SITE

None were taken

OFF-SITE

Beryllium	2.12 mg/kg	10.6 X Value

This, the only surface soil, was found on a property considered to be upwind. The report seems to downplay the amount of beryllium found. That may be true, but if it is, why use the comparison values used throughout the report? The report is quick to point out when levels are below comparison values.

Please see addendum at the end of this report.

SUBSURFACE SOIL
ON-SITE

Arsenic	448.00 X Value
Beryllium	54,500.00 X Value
Cadmium	6.39 X Value
Chromium (total)	3.68 X Value
Copper	5.03 X Value
Lead	no comparison value (932)

OFF-SITE
None were taken

GROUNDWATER
ON-SITE

There were 22 tests done in Dec 1989 (10 shallow - 12 deep)
There were 13 tests done in May 1990 (7 shallow - 6 deep)
There were 4 tests done in Jun 1991 (2 shallow - 1 deep)

	shallow well	deep well
Antimony.....	12.27 X Value.....	7.83 X Value
Arsenic.....	360.00 X Value.....	650.00 X Value
Barium.....	1.08 X Value.....	1.44 X Value
Beryllium.....	82,625.00 X Value.....	68,875.00 X Value
Cadmium.....	26.70 X Value.....	
Chromium(total)	51.00 X Value.....	28.40 X Value
Chromium(IV)...	12.60 X Value.....	27.20 X Value
Lead.....	4.43 X Value.....	4.42 X Value
Manganese.....	185.40 X Value.....	250.00 X Value
Nickel.....	3.37 X Value.....	3.14 X Value
Selenium.....	2.52 X Value.....	????
Thallium.....	Not Detected.....	7.00 X Value
Vanadium.....	7.45 X Value.....	12.05 X Value

Fluoride.....	141.67 X Value.....	266.67 X Value
Nitrate.....	52.40 X Value.....	3.70 X Value
1,1-Dichloroethene	550.00 X Value.....	133.33 X Value
Tetrachloroethene	7.14 X Value.....	5.71 X Value
Trichlorothene.	4.33 X Value.....	1.67 X Value
1,1,1-Trichlorothene	2.05 X Value.....	Below Value
Vinyl Chloride.	230.00 X Value.....	155.00 X Value

I would have liked to see the tests from the 80's included in this study as it may relate to diseases that start showing up in studies in the late 90's and beyond.

OFF-SITE

The problems seem to have been dealt with but serve to point out real potential health problems in the future regarding groundwater. As an example of just the beryllium alone:

Private Well 1	Beryllium 5.3	663 X Value
Private Well 2	Beryllium .... <5.0	625 X Value
Private Well 3	Beryllium .... NA	(NOT ANALYZED)
Reading Crest Well	Beryllium 47.0	5,875 X Value

I included the <5.0 figure for Private Well 2 because 1), it is certainly in keeping with sample values found in groundwater and 2), this symbol represents "contaminant was not detected at the reported value." I don't know what that means. I don't know who does the reporting and who can't detect it.

"...some of the contaminants analyzed for in off-site groundwater are too high." (page 15-paragraph 2)

"...new comparison values show that lower contaminant concentrations may be of health concern." (page 15-paragraph 2)

SURFACE WATER OFF-SITE

BERYLLIUM FOUND IN SURFACE WATER OF LAUREL RUN

DATE	µg/L		SITE
1-13-89	<1	125.0 X Value	US
	1	125.0 X Value	DS
12 - 89	ND		US-1
	2.7B	337.5 X Value	DS-1
	1.5B	187.5 X Value	DS-2

1-26-89	<1	125.0	X Value	US01
	4	500.0	X Value	DS01
	<1	125.0	X Value	DS02
	<1	125.0	X Value	DS03
05 - 90	ND	Not Detected		US-1
	ND	(detected limit		DS-1
	ND	not reported)		DS-2
10-15-91	1	125.0	X Value	US001
	1	125.0	X Value	US002
	<25	3,125.0	X Value	US003
	<25	3,125.0	X Value	DS001
	<25	3,125.0	X Value	DS002
06 - 91	<0.2	25.0	X Value	US-1
	<0.2	25.0	X Value	DS-1
	0.37B	25.0	X Value	DS-2
	0.92B	115.0	X Value	DS-3

Once again I included the "<" figures because this symbol represents "contaminant was not detected at the reported value." I don't know what that means. I don't know who does the reporting and who can't detect it.

BERYLLIUM AND MANGANESE FOUND IN LAUREL RUN ON 5-13-81

Beryllium	1000	125,000	X Value	US1
	2500	312,500	X Value	DS1
	1000	125,000	X Value	DS2
Manganese .	340,000	6,000	X Value	US1
	210,000	4,200	X Value	DS1
	450,000	9,000	X Value	DS2

SEDIMENTS
UPSTREAM (10-1-91)

CONTAMINANT	(μg/L)	
COPPER.....	766	.58% of Value

LEAD.....	248	16.00 X Value
NICKEL.....	39	.39% of Value
TOTAL CHROMIUM.....	<50	?

DOWNSTREAM (NPDES OUTFALL)
(1-17-91 AND 10-1-91, respectively)

BERYLLIUM.....	7,290	911,259.00 X Value
	2,440	305,000.00 X Value
TOTAL CHROMIUM.....	276	5.50 X Value
	160	3.20 X Value
COPPER.....	1,845,000	1,419.00 X Value
	615,000	473.10 X Value
LEAD.....	104,000	693.00 X Value
	11,700	700.00 X Value
NICKEL.....	19,600	196.00 X Value
	7,290	72.90 X Value

Although these samples may be flawed, the ATSDR accepts them. (page 19-paragraph 3). The ATSDR also states that there are no comparison levels, however, goes on to explain these levels as being low. Low compared with what?

I used the comparison values used for water because it was the only measurement using μg/L. I know that this is wrong but if relatively small amounts of beryllium are dangerous to the public, i.e .008 for water, .01 for ambient air, .2 for ground etc., then 7290 & 2440 sounds high no matter what kind of comparison levels are used.

AMBIENT AIR
BERYLLIUM FOUND IN AMBIENT AIR ON-SITE

On-site air was sampled for just 1 month in the middle of the summer (during usually calm days), during a time that the plant was closed down for two weeks (the last two of the month), and wind direction was never recorded.

Having noted that, the following was reported during the three weeks that the plant was open:

STATION	RCRA 01	RCRA 02
7- 2-91	0.00062 1.5 X Value	0.00042 1.1 X Value

7- 9-91	0.00011 27% of Value 0.00023 58% of Value
7-16-91	0.00079 2.0 X Value 0.00034 85% of Value
7-23-91	plant closed down
7-30-91	plant closed down

Over the six sampling events while the plant was operating, 50% were above comparison values.

Chromium levels were exceeded at all sites on all days, varying from a low of 0.00145 (or 18 times the Value) to a high of 0.00827 (or 103 times the Value).

BERYLLIUM FOUND IN AMBIENT-AIR OFF-SITE

The ATSDR document points out, regarding TABLE-7, that abnormal stack emissions are responsible for the high values indicated in 1981's figures. Also that this was corrected by February 6, 1981. (I would guess that any excess contaminants found in the air could be attributed to "abnormalities"). However there is no explanation for the high values reported for 1989.

	1981		1989	
R-1	0.04279	106.00 X Value	0.03769	94.2 X Value
R-2	0.00129	3.20 X Value	0.02105	52.6 X Value
R-3	0.00161	4.00 X Value	0.02046	51.2 X Value
R-4	0.00031	.77% of Value	0.00204	5.1 X Value
R-5	0.00054	1.40 X Value	0.00178	4.5 X Value
R-6	0.00047	1.20 X Value	0.00122	3.0 X Value
R-7	0.00033	.82% of Value	0.00306	7.7 X Value
R-8	0.00026	.65% of Value	0.00181	4.5 X Value

I think the two violations documented in the report could be one of the reasons for the high 1989 levels.

In June and August 1989, there were two events where the limit was violated (6-89 - 0.03721 $\mu g/m^3$ [close to 4 X the limit] and 8-89 - 0.02414 $\mu g/m^3$ [almost double the limit]).

The explanations for these violations is the repair of a drain line, and a subsequent crack in the furnace. In order to make the repair there was excavation on-site. It would seem then that the soil is contaminated with beryllium. It would also seem that the contaminants were carried by wind, since it would be improbable that the stacks were in operation if the furnace was shut

down. I would also imagine that on these two occasions there were precautions taken to keep the soil wet to keep down dust, as opposed to what happens in nature on any given day.

The problem with these two violations is that it is thought in the research of beryllium disease that there is less importance given to dose/duration as there is to the sensitivity of individuals. If this is the case it matters less that a plant has a clean record most of the year but exceeds limits for short periods. These short periods could be just as harmful as lifetime exposures. Not only could the exposures effect sensitive persons, the exposures themselves could contribute to making someone sensitive to future exposures.

The fact that the measurements are given in the hundredthousandths speaks to the toxicity of beryllium.

BIOTA

None were taken.

Although as a child I vaguely remember catching suckers in Laurel Run, I don't believe we ever ate any fish, however we did eat many berries, apples, and cherries.

Response to comment 62: ATSDR developed the ATSDR Public Health Assessment Guidance Manual to provide consistency and guidance in presenting information and writing public health assessments. Although ATSDR will not be revising the public health assessment to present the data in the fashion indicated above, your data and comments are included in this appendix. It should be noted that ATSDR is not responsible for any errors, misrepresentations, or miscalculations made in your analysis of the data, but will attempt to respond to questions raised in those comments. Furthermore, it should be noted that revisions to the public comment release document (e.g., Table 9) may result in apparent discrepancies in the data reported and discussed by the commenter and information in the final release.

Surface Soil, Off-site - As ATSDR indicates in the "Environmental Contamination and Other Hazards" section (pages 10-11), comparison values are health guidelines that are used to select *contaminants of concern* that are then evaluated further. The number of times that a contaminant's concentration exceeds a comparison value is not necessarily a direct indicator of the degree of public health threat posed by a given contaminant. Contaminants that exceed comparison values must be further evaluated, individually, to determine its health threat. Some of the factors that must be considered include actual or potential exposure to a contaminant, the contaminant's concentration, the dose to which one may be exposed, and the strength or evidence of studies upon which the toxicological effects are based.

Groundwater, On-site - The quarterly testing conducted in the 1980's has been reviewed by ATSDR and is referenced in the report. On-site groundwater has not been used for drinking

water and would not provide any insight as to the occurrence of illnesses. Therefore, ATSDR has reported (page 12) that higher concentrations existed in the past, but has characterized the site by including data for current groundwater quality. ATSDR has reported the available off-site groundwater data, which would be more indicative of the concentrations to which people using off-site groundwater may have been exposed.

To address your question about what, "contaminant was not detected at the reported value," means? When laboratories analyze samples they set up detection limits. The lower detection limit (generally referred to as simply "detection limit") is established either as the minimum detection limit believed to be needed by the client requesting the analysis or by the minimum level that the laboratory equipment can detect accurately within established data quality parameters. When the established lower detection limit is exceeded (i.e., when the actual concentration is less than the detection limit) no specific number can be reported with accuracy; therefore, the detection limit is reported with a less than symbol (<) in front of it.

Your comments cite two sentences from the public health assessment (page 15, paragraph 3 of this document; paragraph 2 of the public comment release petitioned public health assessment) out of context. The first sentence states, "Also, the detection limits for some contaminants analyzed for in off-site groundwater are too high." This means that a lower "detection limit" should have been used, if possible, because our comparison value is less (lower) than the detection limit used. The other sentence states, "Although those detection limits may have been appropriate in the past, lower detection limits are now needed since new comparison values show that lower contaminant concentrations may be of health concern." This sentence states the reason that a lower "detection limit" should be sought. The reason is that our new or current comparison value is below the detection limit used, although the detection limit might have been adequate when evaluated against former comparison values. That sentence has been revised in this document to provide clarity.

Sediment, Downstream - The comment regarding sediment asks, "Low compared to what?" and implies that ATSDR is suggesting that the samples reported are low when compared to comparison values. In referring to this petitioned public health assessment (page 17, fifth full paragraph), ATSDR discusses the unusual sediment and the subsequent sample results. ATSDR indicates that the samples were not analyzed as in a typical fashion (on a dry weight basis) and therefore could not be evaluated using sediment comparison values. ATSDR further explains that the sediment should be analyzed properly to evaluate the public health significance. The "low" that ATSDR believes you are referring to is stated as, "Given the generally low level of contaminants in the stream sediments, these results need further confirmation." That sentence is referring to sediment samples as generally being low when compared to other sediment samples (see Table 8).

The sediment samples should not be compared to water comparison values. If a water sample had been collected it would indicate the concentration of beryllium available in the water column and would be evaluated against a water comparison value which is based on the

amount of water typically ingested by a person. Likewise, sediment comparison values are based upon an assumed amount of soil or sediment that a person might ingest. Using the concentration of a contaminant that has been aggressively leached from sediment and reported in a liter solution does not appropriately reflect a drinking water or sediment ingestion exposure scenario.

Ambient Air, Beryllium Found in Ambient Air Off-Site - Table 9 has been revised and the note regarding the 1981 abnormal stack emissions has been deleted. However, the 1981 abnormal stack emissions has been mentioned in the text of the report along with the 1989 NESHAP violations under the "Ambient Air" subsection (page 18).

ATSDR has no indication that actions were taken, during June and August of 1989, to control fugitive dust emissions during excavation. It is believed, at least in part, that the June and August 1989 NESHAP violations resulted from on-site fugitive dust emissions. As an informational matter, refer to the second paragraph of "Response to comment 22" for discussion of the basis of the NESHAPs and the use of comparison values.

Regarding your concern about dose/duration and individual sensitivity, please refer to Response to Comment 61 and 63.

Biota - Thank you for you comment and information.

Comment 63: That the plant has on occasion released large doses of beryllium into the environment for short periods of time.

I believe this is answered in the chart "beryllium found in ambient air off-site." The two violations that I addressed in the report are violations of NESHAPs regulatory limit of 0.01 $\mu g/m^3$, a much higher value than ATSDR's comparison value of 0.0004 $\mu g/m^3$.

Even though the values for beryllium have been decreasing since 1989, they still exceed comparison values at least one week each year (page 18-paragraph 1-2). Considering the fact that there is concern that the "analytical procedure used may not be revealing the total concentration for beryllium (particularly beryllium oxide)," (page 20-paragraph 2) and beryllium oxide being a very toxic form of beryllium, I think that high emission, short duration may be a real health hazard.

Response to comment 63: Regarding the high emission, short duration issue, see the response to Comment 61 above. As stated there, non-occupationally exposed individuals who develop chronic beryllium disease in response to very low levels of beryllium generally represent a hypersensitive subset of the population. The immune response of these individuals to beryllium is similar to an allergic reaction in that it appears to be largely independent of dose. For such hypersensitive individuals, a "safe" level of exposure may be both undefinable and unattainable. NESHAPs regulatory limit of 0.01 $\mu g/m^3$, and not ATSDR's CREG of 0.0004 $\mu g/m^3$, is the more appropriate comparison value in this case, since chronic beryllium disease rather than lung cancer is the more

realistic health concern. Even in occupationally-exposed populations, the evidence that beryllium causes lung cancer in humans is limited; when results were controlled for smoking, they became statistically insignificant. Historical data suggest that the 0.01 ug/m^3 standard has effectively protected people from berylliosis, except perhaps in cases of unpredictable hypersensitivity.

Comment 64: That the report states in several places that "new comparison values" should be considered, as the ones being used may be too high.

> "In 1976, OSHA considered lowering the 2.0 μg/m^3 standard to 1.0 μg/m^3, based largely on evidence of carcinogenicity. But no new standard was promulgated, and the issue was tabled indefinitely."[1]
>
> "The 40-hr-week level for worker exposure of 2 μg/m^3 and the neighborhood level of 0.01 μg/m^3 averaged over a 30-day period were based on guess work and extrapolations from animal studies. It is a source of personal regret and some shame that I could not persuade the A.E.C. to do more outdoor monitoring while area beryllium contamination was a reality."[2]

[1] Kreibel D. Brain JD. Sprince NL. Kazemi H. The pulmonary toxicity of beryllium. *American Review of Respiratory Disease* 1988; 137:464-473

[2] Hardy, Hariet L. Beryllium disease: a clinical perspective. *Environmental Research* 1980 21:1-9

Response to comment 64: ATSDR does not state that new comparison values should be considered because the ones being used are too high. The only place in the public comment release petitioned public health assessment where "new comparison value" is used is in the "Off-site Contamination" subsection (page 15 under the "Groundwater" subsection, second paragraph); however, it is not used to make the above statement. In the "Conclusion" section (page 45), under letter "g" of the data inadequacies list, ATSDR does indicate the need for further research on beryllium because the CREG comparison value is well below background levels commonly found in the environment and because more information on potential, non-cancer, adverse health effects from ingestion of beryllium would be useful.

Comment 65: That the report concentrates on the carcinogenicity of beryllium but doesn't tackle berylliosis or chronic beryllium disease. Less debilitating diseases should also be considered when evaluating NGK.

There are many instances in the report where the subject of beryllium's toxicity is discussed. In almost all the instances it is discussed from it's carcinogenicity and rarely anything else. The comparison levels themselves are in terms of cancer ratios.

In regards to a study at a Reading plant in 1971:

> "The investigators concluded that beryllium exposure in this plant had caused not only clinical beryllium disease but also a "reservoir of nonspecific respiratory disease."[1]

[1] Kreibel D. Brain JD. Sprince NL. Kazemi H. The pulmonary toxicity of beryllium. *American Review of Respiratory Disease* 1988; 137:464-473

Response to comment 65: The comment is well taken. With regard to both occupational and residential beryllium exposure, chronic beryllium disease is, in fact, a more relevant public health concern than cancer. The draft document has been amended to better address this issue. See also the Response to Comment 63, above.

Comment 66: The statement that there has been only one case of nonoccupational chronic beryllium disease reported from 1973-1977.

Research is finally catching up to the initial problems of differentiating between sarcoidosis and chronic beryllium disease. I think that there may be a number of people that might have been diagnosed as sarcoid originally, and may have berylliosis.

> "Five workers at a precious metal refinery developed granulomatous lung disease between 1972 and 1985. The original diagnosis was sarcoidosis, but 4 of the workers were subsequently proved to have hypersensitivity to beryllium..."[1]

Nor do I think that it may have effected only beryllium workers.

> "Chronic beryllium disease continues to occur in the nonoccupational setting and among bystanders in industry, masquerading as sarcoidosis. Because even transient or possibly low levels of exposure may cause disease, this case has important implications for how clinicians, industry, and government agencies define the populations at risk of chronic beryllium disease."[2]

What bothers me is that the report cites one case of nonoccupational chronic beryllium disease between the years 1973 and 1977, excluding 1978 to the present.

The fact is, that the case cited in the quote above was a nonoccupational woman diagnosed with chronic beryllium disease and reported in 1992.

Between 1973 and 1977 fifty-five cases were added. Besides the ATSDR case there were 4 cases for whom the source of beryllium exposure was not listed. (The ATSDR case represent 1.8% of the total. The 4 cases represent 7.2%)

[1] Cullen MR. Kominsky JR. Rossman MD. Cherniack MG. Rankin JA. Balmes JR. Kern JA. Daniele RP. Palmer L. Naegel GP. *et. al.* Chronic beryllium disease in a precious metal refinery. Clinical epidemiologic and immunologic evidence for continuing risk from exposure to low level beryllium fume. *American Review of Respiratory Disease* 1987 Jan;135 (1):201-8

[2] Newman LS. Kreiss K. Nonoccupational beryllium disease masquerading as sarcoidosis: Identification by blood lymphocyte proliferative response to beryllium. *American Review of Respiratory Disease* 1992 May;145 (5):1212-4

Response to comment 66: The relevant section of the assessment has been rewritten to eliminate any potential confusion. The essential point; however, remains unchanged. To quote Newman and Kreiss (1992), "no air pollution or household cases have been reported in more than 30 years". The authors' discovery of a confirmed case of chronic beryllium disease that had been diagnosed as sarcoidosis in 1989 has alerted the medical community to the possibility that more such cases exist, and the availability of the beryllium lymphocyte proliferation test provides a tool for distinguishing between these two diseases. This issue is fully addressed in the final draft of the assessment. (See also the responses to Comments 7, 12-14, 16, 39-40, 61, and 63, above.)

Regarding the fifty-five cases that were added to the Beryllium Case Registry between 1973 and 1977: the date a case was entered into the registry should not be confused with the date of diagnosis. According to Eisenbud and Lisson, 1983, "no cases [of berylliosis] to date have been reported among [occupationally-exposed] individuals first exposed after 1973", and "no cases of berylliosis have been reported from indirect or non-occupational exposure among individuals whose exposure began after about 1950". New cases may yet be uncovered among sarcoidosis patients using the beryllium lymphocyte proliferation test. Such cases will most likely occur among people with a genetically-determined, dose-independent, hypersensitivity to beryllium. No attainable health-based exposure limit can protect all such individuals. However, sometime in the near future it may become possible to identify hypersensitive individuals by means of a biomarker assay, so that they can be warned to avoid, as much as possible, any exposure to beryllium (33). See responses to Comments 39 and 61, above.

Comment 67: The use of U.S. Bureau of Census 1980's figures.

This may not be important right now, but I do believe that accurate populations would be important for future tracking of the incidence of disease in the Cancer Registry, or the U.S. Beryllium Registry.

I also don't know how the approximate figures for population within the one mile and two mile radius were figured. I don't agree with the numbers and I'll attempt to show my reasoning.

THE CENSUS FIGURES

1980 U.S. Bureau of the Census figures (in the document)

(A) Muhlenberg Twp., 1980	= 13,000
(B) Muhlenberg Twp., 1990 (projected)	= 14,000
(C) 1-mile radius of plant	= 9,000
(D) 2-mile radius of plant	= 24,000

(C) If you draw a circle with a radius of 1-mile using the site as center you' Il notice that most of the area includes Temple, South Temple, Cherokee Ranch and a small section of River View Park. It excludes most of River View Park, most of Muhlenberg, most of Laureldale, and all of Hyde Park. However according to the population figures in (B), accounts for approximately 64% of Muhlenberg's population.

(D) Although the 2-mile radius includes a little more land area than that of Muhlenberg Twp, (12.56 sq. mi. as opposed to 11.3 sq mi.), most still falls within Muhlenberg. The approximately 1/3 that doesn't is in rural Ontelaunee Twp. However according to the figures in (D) the population almost doubles! (171%)

If broken down into simple persons/sq. mile (using ATSDR's figures) it would look like:

(B) Muhlenberg = 1,118 persons/sq. mile
(C) 1-mile radius = 2,866 persons/sq. mile
(D) 2-mile radius = 1,911 persons/sq. mile

I also believe that 1990's figures should be used. Especially Temple's as they are the group most likely effected.

1990 U.S. Bureau of the Census Figures

Muhlenberg Twp. 1990 = 12,636
Temple Boro. 1990 = 1,491

Response to comment 67: As suggested, we have updated the 1980 population data included in the public health assessment to reflect the more current figures from the 1990 U.S. Census. The 1990 population figures within one and two miles of the NGK Metals facility were derived using Geographic Information System (GIS) technology. GIS was used to identify the population in census blocks within a one and two mile radius of the NGK Metals facility (4,927 and 14,686 people, respectively).

As shown in Figure 10, Temple Borough and part of Muhlenberg Township (most notably South Temple and a small portion of River View Park) are located within 1 mile of the facility. Located within the 2-mile radius are Temple Borough, most all of Muhlenberg Township, Laureldale Borough and rural parts of Bern Township and Ontelaunee Township. There may be some confusion about the population figures within a one and two mile radius of the facility because Temple and Laureldale Boroughs are within Muhlenberg Township but not included in that Township's population figures.

Comment 68: COMMUNITY HEALTH CONCERNS EVALUATION
NUMBER 5: The detrimental effects of Laurel Run on wildlife, etc.

Even if the 1981 values are discounted for being too far in the past or misread, etc., there are levels recorded for beryllium on 1-26-89 at 4 μg/L (500 times the comparison value), on 12-89 at 2.7 (337.50 times the comparison value), and on 6-91 at .92 (115 times the comparison value).

Beryllium levels were high in 4 of the five tests. The fifth time the "detection limit was not reported."

With regards to the sediment, the Document records elevated levels at all sampling sites on all 3 days at all three sites, ranging from a low of .24 mg/kg (1.2 times the value) to 2.4 mg/kg (12 times the comparison value).

However it also records 2 other days samples, on 10-1-91 and 9-17-91. Although these samples are flawed, I still think it important that wherever there are ATSDR comparison levels given for beryllium, they are usually very low, i.e., 0.008 μg/L, 0.2 mg/kg, 0.0004 $\mu g/m^3$ etc.

In this sampling event the levels for beryllium are 7,290 and 2,440 μg/L. Copper was 1,845,000 and 615,000 μg/L, and lead was 104,000 and 11,700 μg/L. These numbers for a lay person seem very high.

NUMBER 10: ATSDR recommends surface soil testing downwind of NGK.

I strongly agree. If there are no more stack emissions as a result of the furnace shutting down, then the source of beryllium in ambient air would probably be wind, and dust being kicked up in play etc.. Since it is probable that most beryllium diseases are caused by inhalation, I think if nothing else is done, this may be the most important.

NUMBER 18: NGK's procedures provide for protective garments for plant workers and require showers at the end of each work day.

Since starting this paper I have come in contact with four people who had worked at either Cabot Berylco or Brush Wellman and have been diagnosed as having chronic beryllium disease. One was a secretary, one was a salesman, neither worked in the plant, and neither was required to wear protective clothes.

NUMBER 19: ATSDR has not done sampling to detect whether contaminants have migrated off-site to other areas and recommends additional testing.

Again, because of the possibility of children playing, raising dust, and inhaling it, I think this is a very important step in finding possible areas of contamination.

NUMBER 20: ATSDR has determined that the levels of contaminants in the groundwater are not likely to cause respiratory infections, mottled teeth, stress fractures, and colic in children.

Perhaps not. However just the beryllium found in "Private Well 1," was 5.3 μg/L (662.5 times the comparison value). When does the "value" get too high? This document attempts to explain that beryllium is not toxic when ingested yet it assigns a CREG value of 0.008 μg/L for water to it.

NUMBER 22: Concerning the possibility of being on-site before the facility was fenced in.

I'm not sure. I do know that when we were young we played in Temple Cave, which, I remember to be just across the road from the disposal areas, played in a cemetery across from the plant, found large pieces of slag across from the plant, and played in large "silt" basins where we discovered large quartz crystals.

NUMBER 23: The possibility of illnesses around the site, particularly in the Cherokee Ranch area.

I find it hard to believe that local doctors and hospitals weren't contacted. Even more important than soil testing I think that area doctors, pulmonary specialists, and hospitals should be interviewed, not just regarding cancer, but also for other respiratory illnesses, with particular attention to sarcoidosis. It might be the first line of defense. With such a long latency period for chronic beryllium disease and cancer, an increase in incidence of disease may not show up for decades. Doctors and hospitals might be the first to notice abnormalities in their patients.

NUMBER 24: The communication to the public of the possible health hazards surrounding NGK.

I live far from the area and purely by luck learned of the public health assessment. I'm grateful that I learned of it and have had a chance to participate.

NUMBER 26: Sampling of stream sediments are again recommended.

I would also recommend sampling soil from the banks, where, when the water recedes the sediment is deposited to become dirt, and later, dust. Also areas close to Laurel Run, as I know of quite a few times that it flooded.

NUMBER 27: This deals with orange colored ash from the stacks in the past.

I would think that there must be industry records that exist that would tell what might be likely to make up orange colored smoke billowing from a beryllium plant. (For example: the smoke from the exhaust of a car burns bluish-black when burning too much oil, or white when there is moisture present, etc.).

NUMBER 30: The question of chronic beryllium disease and sarcoidosis.

This is pretty much the way that I as a lay person understand it as well. I just wonder how many people who have lived around the plant may have been misdiagnosed with sarcoidosis and other lung related illnesses.

Response to comment 68: Number 5 - The concentrations of the contaminants detected in the September 17, and October 1, 1991, samples are certainly indicative of contamination from some source. However, as discussed in the "Response to comment 62," under "Sediment," ATSDR is unable to determine the level of contamination and its impact on public health, as well as wildlife.

Number 10 - Off-site surface soil sampling for beryllium and chromium has been conducted. An evaluation of that data is in the "Public Health Implications" section (pages 30-31 under the beryllium "Ingestion Exposure" subsection), which indicates that no adverse health effects are expected.

Number 18 - This public health assessment will be forwarded to the National Institute for Occupational Safety and Health (NIOSH) for follow-up on worker related issues.

Number 19 - Please refer to the above response regarding community health concern "Number 10."

Number 20 - ATSDR does not establish health standards, but evaluates each site, contaminant, and pathway on an individual basis since a number of varying factors must be considered. The concern about the CREG comparison value has been addressed in the body of this report (page 30 under the beryllium "Ingestion Exposure" subsection) and in other responses to comments (please refer to "Response to comment 46" second paragraph).

Number 22 - Thank you for your comment and information.

Number 23 - During the public health assessment process, ATSDR reviews available health outcome data. However, active collection of health information, such as surveillance or studies, is typically not conducted until after the public health assessment is conducted and reviewed by ATSDR's Health Activities Recommendation Panel. That panel makes recommendations for appropriate health follow up if warranted.

Number 24 - Thank you for your comment.

Number 26 - ATSDR has recommended additional sediment sampling. Although ATSDR would evaluate any soil samples collected from Laurel Run's banks and flood plain, such sampling is not being recommended at this time.

Number 27 - Based on information provided from state personnel, NGK uses nitric acid in cleaning (via a pickling bath) beryllium-copper strip. Urea is manually added to this process to control a brown-orange nitrogen emission. This cleaning process does not result in any beryllium emissions.

Number 30 - ATSDR does not routinely request or review personal medical records. ATSDR is only aware of cases of sarcoidosis and beryllium disease that have been reported by individuals to us.

Comment 69: DATA GAPS or DATA INADEQUACIES

c. I think the groundwater characterization should be done, not only to the southeast (downgradient), but also from the northeast part of the site where the ground water runs north.

e. I think that the Reading Eagle-Times would have the wind direction in the weather reports for July 1991.

f. SEE i.

g. The statement, "The unusual sediment may no longer be present for sampling." sounds as if you don't know if it exists or not. I think that would be an easy matter to verify.

i. This report states that "the CREG for beryllium in soil is currently well below background levels commonly found in the environment." However, back at "i" the report states "Local background beryllium soil concentrations are not available."

Also, I don't think ingestion is the most important health threat, inhalation is. But the dust on a property would provide this health risk. I also think that, chronic beryllium disease with latency ranging anywhere from 10 to 40 years is as important to investigate as cancer. If there is a health threat that exists today it may not be known for decades.

j. Is it that there are no comparison levels for lead or that they are just not known?

Response to comment 69: Information to fill data gap "e" and "b" have been obtained or are no longer necessary and therefore the alphabetic ordering in this public health assessment has changed. However, the alphabetic ordering in the above comment and this response remains unchanged and corresponds with that of the public comment document.

c. ATSDR has made the recommendation (page 46, Recommendation 5) for characterization, remediation, or other actions that are protective of public health.

e. ATSDR was able to obtain applicable surface weather observations (wind direction data) from the National Climatic Data Center.

g. ATSDR simply acknowledges that the unusual sediment may have resulted from an isolated incident and no longer be present in the stream; nonetheless, ATSDR has recommended (page 46, Recommendation 6) follow up sediment sampling.

i. ATSDR used background soil data from locations within the United States to explain that the CREG is well below background levels commonly found in the environment. ATSDR stated that "Local background beryllium soil concentrations are not available" because soil background levels for Reading, Pennsylvania, specifically in the area near NGK, are not available.

ATSDR attempts to evaluate all routes and pathways of exposure. Through the public health assessment process, available health outcome data is evaluated (i.e., state cancer data), active collection of health outcomes is conducted if warranted and recommended by ATSDR's Health Activities Recommendation Panel (i.e., health studies).

j. There are no comparison levels for lead.

Comment 70: RECOMMENDATIONS

I agree with the recommendations.

I also recommend that the U.S. Beryllium Disease Registry be examined.

I recommend that doctors and hospitals in the area be contacted and interviewed, not just to see if there is a health risk right at this time, but also to be aware of any increases in lung related diseases.

I recommend that hospitals records could be checked to see if there is an increase of bronchoscopies, etc.

Response to comment 70: Active data collection, such as described in your last two recommendations must be recommended by our Health Activities Recommendation Panel. Regarding the U.S. Beryllium Disease Registry, ATSDR does not believe that this national registry would be useful in examining local incidence. ATSDR has reviewed articles, as discussed in the Response to Comment 66 (second paragraph), that cite national exposure incidence.

APPENDIX E

Case Reports

Nonoccupational Beryllium Disease Masquerading as Sarcoidosis: Identification by Blood Lymphocyte Proliferative Response to Beryllium[1-3]

LEE S. NEWMAN and KATHLEEN KREISS

SUMMARY Chronic granulomatous lung disease caused by industrial exposure to beryllium continues to occur, but no community cases have been reported in more than 30 yr. With the advent of a blood screening test that detects beryllium sensitization, physicians can discriminate chronic beryllium disease from sarcoidosis. A 56-yr-old woman in whom sarcoidosis was diagnosed had an unremarkable occupational history, but her husband was a beryllium production worker. Blood and bronchoalveolar lavage lymphocyte transformation tests, measuring the beryllium-specific cellular immune response, were abnormal, confirming a diagnosis of chronic beryllium disease. Chronic beryllium disease continues to occur in the nonoccupational setting and among bystanders in industry, masquerading as sarcoidosis. Because even transient or possibly low levels of exposure may cause disease, this case has important implications for how clinicians, industry, and government agencies define the populations at risk of chronic beryllium disease.

AM REV RESPIR DIS 1992; 145:1212-1214

Introduction

Chronic beryllium disease is an occupational granulomatous lung disorder. It afflicts the small percentage of beryllium-exposed workers who develop beryllium-specific, cell-mediated immunity (1-5). Interestingly, nonoccupational chronic beryllium disease has been described among residents living in the community surrounding a beryllium production plant (6, 7) and among family members of beryllium workers who were presumably exposed to beryllium-contaminated clothing (6-8). But no air pollution or household cases have been reported in more than 30 yr (9, 10). The disappearance of such cases has been attributed to improved control over air emissions and improved work practices such as mandatory work clothes exchange (8, 11). Alternatively, household and community cases of beryllium disease may still be occurring but are unrecognized or misdiagnosed. Because chronic beryllium disease is readily confused with sarcoidosis (12), persons in the community with this disorder may be misclassified as having granulomatous lung disease of unknown etiology.

With the advent of a specific and sensitive blood test of the cell-mediated immune response to beryllium, screening for the presence of beryllium sensitization and chronic beryllium disease among beryllium-exposed workers is possible (1, 13). This test, called the beryllium lymphocyte transformation test (BeLT), is the one reliable method of discriminating between beryllium disease and sarcoidosis (5). In fact, the BeLT has become a key diagnostic tool for chronic beryllium disease detection in some industries (1, 2, 14, 15). This test could also be used to identify and diagnose nonoccupational cases of chronic beryllium disease.

Case Report

A 56-yr-old Caucasian woman had been in her usual state of good health until approximately 1985 when she insidiously developed exertional dyspnea. She sought medical attention in November 1988, when she experienced more acute shortness of breath and right-sided pleuritic chest pain. Chest radiograph at that time demonstrated bilateral interstitial infiltrates and hilar lymphadenopathy. Despite two courses of intravenously administered antibiotics and supplemental oxygen, her symptoms worsened, and her chest radiograph showed increasing profusion of interstitial opacities over the next 2 months. In February 1989, open lung biopsy of the right middle lobe demonstrated noncaseating granulomas (figure 1), Schaumann bodies and cholesterol clefts, lymphocytic infiltration of lung parenchyma, and interstitial fibrosis. Peribronchial lymph nodes showed confluent noncaseating granulomas. Examination under polarized light showed birefringent material within granulomas. Special stains and cultures for acid-fast bacilli, bacteria, and fungi were negative. The patient was told she had sarcoidosis. Treatment with prednisone was initiated at 80 mg/d, tapered, and subsequently discontinued in June 1990. Prednisone was reinitiated 3 wk later because of worsening symptoms and radiographic progression.

The past medical history was free of any previous respiratory conditions, allergies, or known tuberculosis exposure. She was a lifelong nonsmoker who had always resided in Ohio. She had been self-employed, selling cosmetics and baby-sitting, raising her children, and, since 1973, doing stockroom work for a retailer.

Of note, her pulmonologist learned that the patient's husband worked from 1959 to the present at a beryllium production plant, with daily exposure to beryllium. The husband's principal beryllium exposure had been to beryllium oxides while operating furnaces and attrition mills, transferring beryllium oxide powder, machining, and metallizing beryllium ceramics. Throughout the entire time of his employment, his employer required work clothing exchange, and the husband showered at work before returning to his street clothes at the end of the shift. The family had always resided at least 28 miles from the two beryllium plants at which the husband had worked.

The patient had only been to the plant on two occasions. During one open house in the 1960s, she took a brief tour through the operating plant; once in the 1970s, she toured while it was not operating. She may have come in contact with beryllium at three other times. (*1*) For several months in 1976, her husband was an advisor to a new ceramics plant, where he did no hands-on work and wore street clothes, which his wife helped clean on several occasions. (*2*) In February 1979, a hydrogen furnace containing beryllium oxide exploded in her husband's face. He was rushed to the local emergency room, wearing contaminated work clothes. Upon his discharge from the emergency room, the patient was handed her husband's work clothes, which she placed in a plastic bag at home and returned to the plant guardhouse. Over the next several months, she scrubbed her husband's face several times a day with a motorized rotary brush, removing embedded metallic debris. (*3*) In September 1987, the patient's husband injured his ankle while on the job. When she retrieved her husband from the hospital, he was still wearing his work clothes. After riding home in her car, the husband carefully removed these dust-covered clothes and placed them in a plastic bag.

After eliciting this history in the summer of 1990, the treating physician sent a peripheral blood specimen by overnight courier to the National Jewish Center for Immunology and Respiratory Medicine for blood BeLT. The blood result demonstrated

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[2] Supported by Physician Scientist Award ES-00173 and Grant ES-04843 from U.S. Public Health Service, National Institutes of Health.

[3] Correspondence and requests for reprints should be addressed to Lee S. Newman, National Jewish Center for Immunology and Respiratory Medicine, Room D-104, 1400 Jackson Street, Denver, CO 80206.

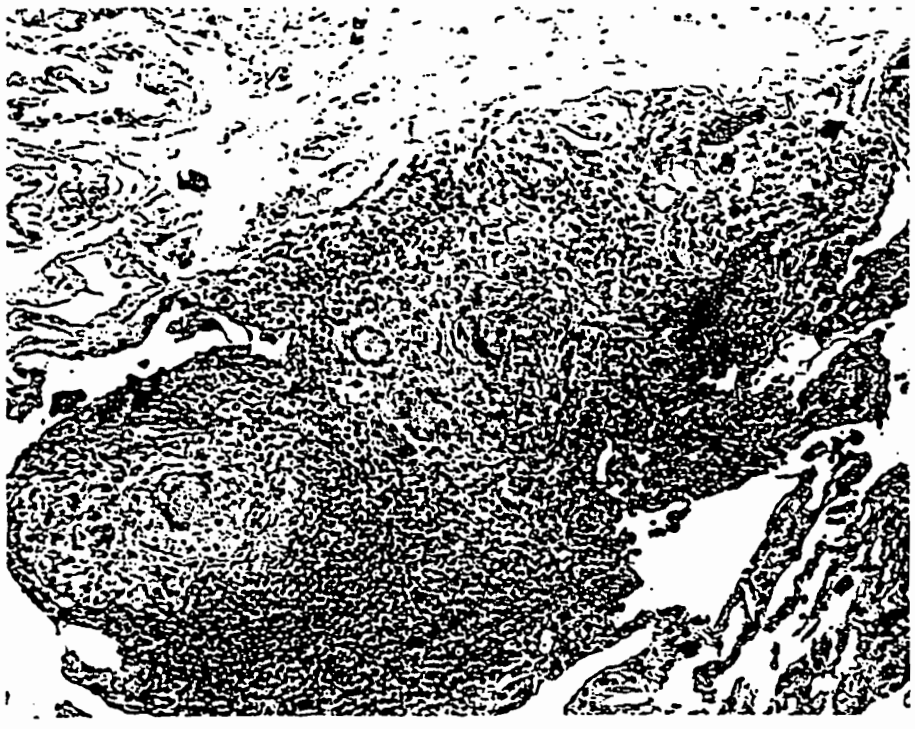

Fig. 1. Open lung biopsy from a patient with nonoccupational chronic beryllium disease demonstrates multiple noncaseating granulomas, multinucleated giant cells, mononuclear cell interstitial infiltrates, and interstitial fibrosis (hematoxylin-eosin stain; magnification: ×10).

beryllium sensitization, with an abnormal median peak stimulation index of 11.9 (normal < 1.4, based on mean of medians of three highest stimulation indices for 26 normal subjects + 2 SD) (13) leading to her referral to our institution for further evaluation in September 1990. Interestingly, the patient's husband's blood BeLT was normal, as is the case for most beryllium-exposed workers (1).

At the time of her evaluation, she reported exertional dyspnea and intermittent nonradiating right-sided chest pain. She denied cough, fever, night sweats, or weight loss. Medications included prednisone 40 mg every other day, verapamil hydrochloride 240 mg four times a day, furosemide 40 mg a day, and calcium and potassium supplements.

Physical examination abnormalities included a Cushingoid appearance, early bilateral cataract formation, bibasilar dry rales extending to the midlung fields, and trace pedal edema. Laboratory data were notable for elevated hematocrit (0.48) and hemoglobin (16.3 g/L). WBC count, differential, and biochemistry panel were normal. ANA was 1:80 (speckled pattern), with a negative rheumatoid factor and normal erythrocyte sedimentation rate. Serum angiotensin-converting enzyme activity was 25 U/L, (normal, 8 to 52 U/L). Chest radiograph was unchanged from the 1988 radiograph, but it showed interval improvement compared with a radiograph from June 1990 when the patient had deteriorated while not receiving corticosteroids.

Pulmonary function testing by body plethysmography showed restrictive physiology and normal airflow (FEV_1, 1.75 L [69% of predicted]; FVC, 2.03 L [62%]; total lung capacity, 3.22 L [75%]). Single-breath carbon monoxide diffusing capacity corrected for hemoglobin was low (10.78 ml/min/mm Hg [43%]) (16, 17). Resting room-air arterial blood gas measurements performed in Denver (5,280 ft) showed hypoxemia (pH, 7.40; P_{CO_2}, 37 mm Hg; P_{O_2}, 48 mm Hg). With the patient breathing supplemental oxygen (~29%), the arterial P_{O_2} fell from 102 mm Hg at rest to 61 mm Hg with maximal exercise, and the alveolar-arterial difference widened from 21 to 77 mm Hg. Electrocardiogram demonstrated normal sinus rhythm, zero-degree axis, and p pulmonale.

Bronchoalveolar lavage was performed and analyzed following standard protocols (18, 19). There were 62 × 10^4 white cells/ml lavage fluid (nonsmoking normal, 12.9 × 10^4 ± 2.0 SEM), with 41% lymphocytes (11.8 ± 1.1), 56% macrophages (85.2 ± 1.6), and 2% neutrophils (1.6 ± 0.07) (20). As illustrated in figure 2, the BeLT using bronchoalveolar lavage mononuclear cells was notably abnormal, with median peak stimulation index of 149.2 (normal < 3.8 based on mean median peak stimulation index + 2 SD for 17 patients with sarcoidosis), confirming the diagnosis of chronic beryllium disease (2, 5). Repeat of the blood BeLT yielded an elevated median peak stimulation index of 6.8. As further confirmation of exposure, the original biopsy specimen was submitted to Dr. W. Jones Williams for laser microprobe mass spectrometry by methods previously described (21, 22). This technique, which is capable of detecting beryllium in the range of 1 to 10 ppm on paraffin sections, found beryllium within this patient's granulomas and Schaumann bodies, as illustrated in figure 3.

Discussion

Chronic beryllium disease has generally been described among workers in whom a history of past beryllium exposure has been elicited. However, 65 nonoccupational cases were reported to the U.S. Beryllium Case Registry during the 1940s and 1950s, arising from a time when the beryllium industry did less to control environmental exposures. Twenty-three of these cases were attributed to household exposure to dust brought home on work clothes and 42 to air pollution (8). However, even with improvements in control of industrial exposure, occupationally related beryllium disease continues to occur in an unchanged small percentage of exposed workers. The actual number of current and former beryllium-exposed workers in the United States is unknown.

Because of the clinical availability of the blood BeLT, we have been able to confirm this as the first new case of nonoccupational chronic beryllium disease to be reported in 30 yr. This patient's symptoms, clinical course, and radiographic, physiologic, and pathologic derangements are all typical of advanced chronic beryllium disease (12). Her case meets current and past case definitions (2, 23), including those that require demonstration of an abnormal bronchoalveolar lavage BeLT (2, 5).

This is the first time that a nonoccupational case of chronic beryllium disease has been identified using a blood marker of beryllium-specific cellular immunity. This case suggests that a subset of sarcoid patients with negative occupational histories actually have beryllium disease, and that the blood BeLT can help in case ascertainment. Recent data suggest that the blood BeLT may be almost interchangeable with the more invasive bronchoalveolar lavage version of this test (13). In our hands, the blood BeLT is positive in 94% of cases of chronic beryllium disease in whom lavage BeLT is abnormal, and is negative in other granulomatous diseases (2, 13).

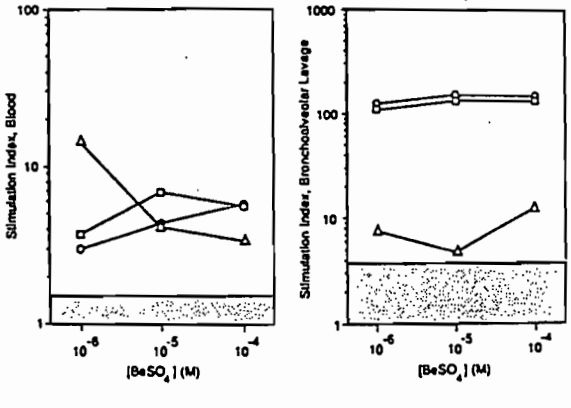

Fig. 2. Comparison of blood and bronchoalveolar lavage BeLT responses by beryllium sulfate concentration [$BeSO_4$] in a patient with nonoccupational chronic beryllium disease. Symbols represent stimulation indices for cells after 3 (*circles*), 5 (*squares*), and 7 (*triangles*) days in culture. Normal ranges for median peak stimulation index are shown in gray. For blood, counts per minute of tritiated thymidine uptake ranged from 374 ± 58 for unstimulated cells to 5,542 ± 1,420 for beryllium-sulfate-stimulated cells. For lavage, counts per minute of tritiated thymidine uptake ranged from 521 ± 70 for unstimulated cells to 89,619 ± 9,876 for beryllium-sulfate-stimulated cells.

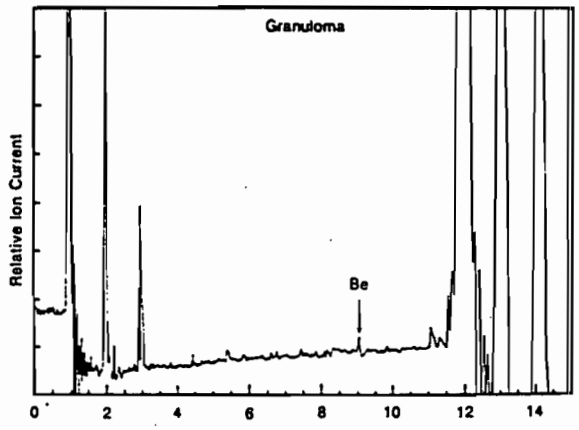

Fig. 3. Laser microprobe mass spectrometry demonstrates beryllium (Be) peak within the lung granuloma of this patient with nonoccupational beryllium disease. This analysis was performed by Professor W. Jones Williams (University of Wales College of Medicine).

However, not all laboratories performing the test have found such high correspondence between blood and lavage BeLTs (5).

This case has implications for how clinicians, industry, and government agencies define "beryllium exposure." Although it is impossible to know the dose of beryllium inhaled by our patient, her exposure would have been considered "trivial" by most physicians. For occupational air exposures, a permissible level of 2 $\mu g/m^3$ (8-h time-weighted average) with peak levels of less than 25 $\mu g/m^3$ is required. Previous research has suggested that beryllium exposures below existing regulatory standards may be sufficient to cause disease (6, 14, 24).

From a clinical standpoint, the correct diagnosis of chronic beryllium disease has implications both for patient prognosis and for prevention of disease in the community. Every patient with granulomatous lung disease should have a careful occupational and environmental history taken and if a history of direct or indirect contact with beryllium is elicited, additional testing be performed. This case suggests that until more is known, even persons with seemingly minor, incidental beryllium exposure should be considered to be at risk. As such, beryllium-using industries may need to include evaluation of passively exposed persons within the workplace when establishing beryllium surveillance programs and to notify employees of possible risk to their households. A much larger population may be at risk than is recognized.

Acknowledgment

The writers wish to thank David M. Atwell, M.D., and his patient for their contributions to this research. They also wish to thank Clara Wise, MT (ASCP), Jeri Teague, MT (ASCP), Ronald Harbeck, Ph.D., Beverly Schumacher, and Alma Kervitsky, CRTT, for their assistance in the laboratory, and Margaret Mroz, MSPH, for her assistance in data analysis.

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Epidemiology of Beryllium Sensitization and Disease in Nuclear Workers

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We examined the epidemiology of chronic beryllium disease among a stratified, random sample (n = 895) of nuclear weapons workers using the blood beryllium lymphocyte transformation (BeLT) test and chest radiograph for case identification. Of 18 new cases of beryllium sensitization, 12 had beryllium disease, and three more developed pulmonary granulomas on lung biopsy over the succeeding 2 yr. Beryllium-sensitized cases did not differ from noncases in age, gender, race, ethnicity, smoking, most respiratory symptoms, spirometric or radiographic abnormalities, or job tenure. The six sensitized cases without initial disease differed from beryllium disease cases in having greater pack-years of smoking. Sensitization occurred among workers with inadvertent or bystander exposure, such as a secretary and security guard. However, beryllium sensitization risk was higher for machinists (4.7%) and for persons reporting measured overexposure (7.4%, odds ratio 5.1); exposure beginning before 1970 (3.6%, odds ratio 2.7); consistent beryllium exposure (3.4%); and sawing (4.7%) or band sawing (6.0%) of beryllium metal. We conclude that both individual susceptibility to sensitization and exposure circumstances are important in developing disease.
Kreiss K, Mroz MM, Zhen B, Martyny JW, Newman LS. Epidemiology of beryllium sensitization and disease in nuclear workers. Am Rev Respir Dis 1993; 148:985–91.

In beryllium industries, screening of workers for beryllium disease can rely on blood tests of the cell-mediated immunity to beryllium that accompanies the disease and distinguishes it from sarcoidosis. In the beryllia ceramics industry, the beryllium-specific lymphocyte transformation (BeLT) test had high positive and negative predictive values for beryllium disease in a work force with beryllium oxide exposure concluding approximately 15 yr earlier (1). Now that a sensitive and specific test is available to identify both subclinical and clinical disease, we can reexamine the epidemiology of beryllium disease in population-based screening. We report here a cross-sectional study of beryllium workers in a nuclear weapons plant where beryllium exposure was ongoing, permitting us to examine the relationships among beryllium sensitization, beryllium disease, job-related factors, and personal attributes. Our findings have implications for the conduct of beryllium disease surveillance in industry, as well as for disease prevention.

We sought to determine whether (*1*) beryllium-sensitized workers identified in blood BeLT test screening have or progress to beryllium disease; (2) surveillance by chest radiograph identifies additional cases of beryllium disease that have normal blood BeLT tests; (*3*) workplace exposure indices, such as process or job title and duration of beryllium exposure, are associated with risk of beryllium sensitization; and (*4*) personal attributes, such as age and smoking status, are associated with risk of beryllium sensitization and disease.

In the nuclear industry, beryllium is used as a neutron moderator, with occupational exposures occurring in the forming and machining of beryllium metal. The plant began using beryllium in 1951 and was unique in the beryllium industry in having beryllium casting operations until 1979. Casted parts were welded into stainless steel cans, rolled into sheets, and decanned by shearing. These parts and billets produced elsewhere were machined, ground, welded, assembled, and inspected. Nonproduction operations included research and development, chemical analysis, and mechanical property testing.

METHODS

Population

Between 1987 and 1990, the entire plant population was given a one-page survey about beryllium exposure, and 3,305 employees not known to have beryllium disease returned it to the corporate medical department (figure 1). Study personnel then classified these employees into no exposure, minimal or casual exposure, definite exposure, or beryllium worker groups for the purpose of stratified sampling. We selected a stratified random sample of 1,247 employees from this group of 3,305, inviting all beryllium workers to participate who had not been previously screened. We selectively sampled the remaining three groups with the intention that 10% of participants would have no exposure, 10% minimal or casual exposure, and 40% definite exposure. Of the selected employees, our interviewer made contact with 1,022; 119 had left employment before they were con-

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Beryllium Disease Screening in the Ceramics Industry

Blood Lymphocyte Test Performance and Exposure-Disease Relations

Kathleen Kreiss, MD
Stephanie Wasserman, MSPH
Margaret M. Mroz, MSPH
Lee S. Newman, MD

We identified nine new cases of biopsy-confirmed chronic beryllium disease among 505 employees and ex-employees in a company that had manufactured beryllia ceramics from 1958 through 1975. Of tests commonly used in medical surveillance, only a confirmed blood beryllium lymphocyte transformation test had a high positive predictive value for beryllium disease (100%). However, two beryllium disease cases had either a normal or inconsistently abnormal blood test and were identified for diagnostic workup by abnormal chest radiograph. The only risk factor for beryllium disease was beryllium exposure; smoking or allergic history did not affect risk. Degree of beryllium exposure was associated with disease rates, which ranged from 2.9% to 15.8% for beryllia-exposed subgroups. One case of beryllium disease occurred in a "dust-disturber" who did not report past beryllium exposure and who began employment 8 years after commercial beryllia production had stopped. Our data support efforts to prevent beryllium disease by lowering beryllium exposures and to identify subclinical and early disease by broad-based medical surveillance using the blood beryllium lymphocyte test and chest radiograph in beryllium-using industries.

The detection and prevention of beryllium disease in the workplace has been hampered by both the lack of a sensitive and specific surveillance test and our inability to identify specific subgroups of high-risk workers. In previous work, we showed that a blood immunologic assay, the beryllium lymphocyte transformation (BeLT) test, identified beryllium-sensitized nuclear workers, most of whom had beryllium disease on lung biopsy.[1] Questions of predictive value precluded our recommendation at that time for industry-wide use of the blood beryllium lymphocyte test in surveillance for beryllium disease. A screening test with good predictive value could be targeted to employees with beryllium disease-related risk factors. However, the association between dose and disease risk has been called into question by data presented in the last decade.[2,3]

We report here 1) our evaluation of the blood BeLT test in the beryllia ceramics industry, in comparison to other screening tests and 2) our assessment of disease rates and risk factors, which extends the epidemiology of chronic beryllium disease to another industry using current diagnostic techniques.

The ceramics company produced ceramics from beryllia (BeO) from 1958 through 1975 and has continued to metallize circuitry onto beryllia ceramics manufactured elsewhere until now. Our interviews with current and former employees, management, and health and safety personnel confirmed that beryllia had been handled with knowledge of its risks and use of glove boxes, exhaust ventilation, and respiratory protection. During an early 5-

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